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A computerized trajectory model is described that computes near-surface air parcel motions. Results are presented for a study of 50 trajectory case studies during the summer 1975 St. Louis experiments.

It is concluded that the use of RAMS minute-averaged data has been made a fully operational segment of the trajectory model and produces a detailed and accurate description of the urban wind field. The model can be modified to accept wind observations on any time or distance scale.

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NEAR-SURFACE AIR PARCEL TRAJECTORIES -ST. LOUIS, 1975

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The utility of air parcel trajectories is described for the diagnosis of mesometeorological and urban air pollution problems. A technique is described that utilizes the St. Louis Regional Air Monitoring System (RAMS) to provide wind measurements for the local urban scale.

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SECTION 1

INTRODUCTION

THE UTILITY OF NEAR-SURFACE URBAN-SCALE AIR PARCEL TRAJECTORIES

The objective analytic prediction and diagnosis of air motions has long been the goal of a large segment of the meteorological discipline. Since the advent of the computer, the upper atmosphere and now the lower boundary layer have been examined intensively for techniques that can aid us in the answering of two basic questions: "Where did the air at a particular location originate?" and "Where is it going?"

More recently, emphasis has been increasingly placed on smaller spacial and temporal scales to include mesometeorological and micrometeorological problems, and even interdisciplinary questions involving the realms of geography, chemistry, and physics. The solutions to these lower boundary layer problems cannot be accomplished using conventional predictive or diagnostic techniques.

The path traced by an air parcel, commonly called a trajectory, is vitally important to scientists of all disciplines since air is the carrier of weather and other physical parameters that interact with man at any given location. Near-surface air parcel motions are also indicators of small-scale meteorological processes in the lower boundary layer that are outside the resolution of conventional analysis.

In the urban scale trajectories can be useful in many aspects. Air pollution meteorologists attempt to recreate local smoke and pollution plumes using the local windfield and Gaussian assumptions. The plumes can be traced backward in time (backward trajectories) to locate the path along which the probable source is located. If the source is known, the projected plume path (foreward trajectory) can be derived to determine the area which will be affected downstream.

Air quality measurements are, of course, affected by the ambient atmosphere and its past history. Documentation of the vertical structure of the wind and thermal fields should be accompanied hand-in-hand with the spacial movement of these fields over the measurement site. Calculation of trajectories, both foreward and backward, originating at the experiment and a series of synoptic trajectories to define the wind field are seemingly essential to the eventual success of the data interpretation of the experiment.

It is also obvious that some methodology must be derived to mesh with the analytic formulations of wind calculations that exist for all geostrophic levels down to the near-surface boundary layer. Urban models are caught in the time and space scales that defy similar analytic solutions. New techniques combined with high resolution and frequent data measurements are necessary to produce a realistic air flow model in the surface boundary layer.

In the diagnostic sense many empirical solutions relating to radiational or roughness interactions with the atmosphere can be derived by studying the detailed observed wind patterns in the local framework provided by an accurate trajectory model.

The near-surface trajectory model should be versatile enough to handle any type and scale of input wind data. Not enough emphasis can be placed on the formation of a sophisticated data network such as the St. Louis Regional Air Monitoring Networks (RAMS) and the complementing of field experiments with both horizontal and vertical meteorological data.

DEVELOPMENT OF AN IN-HOUSE TRAJECTORY MODEL

During the summer of 1973 Environmental Quality Research, Inc. was involved in the Aerosol Characterization component of the EPA's St. Louis field study. This was one of the first opportunities for aerosol physicists, air chemists, and meteorologists to combine efforts toward a detailed study of urban air pollution transport processes. Trajectories were produced through laborious hand analysis to document how the St. Louis heat island affects the transport of local pollution emissions.

In March 1974 the results of the preliminary trajectory study was presented at the Fifth Conference on Weather Forecasting and Analysis

(Dannevik; et al, 1974). Positive reaction to this work prompted the further in-house research that resulted in the objective Model* used to derive the results presented in this Final Report.

Efforts to obtain funding for additional trajectory calculations began early in 1974 and were finally awarded in February 1975. A list of possible trajectory calculations was formulated to correlate with the summer 1975 Air Pollution Intensive during the month of August. Options for foreward and backward 2-dimensional trajectories were provided by EQR.

SCOPE OF REPORT

The scope of this Final Report documents the Contractor's

1. development of a trajectory model
2. evaluation of the trajectory model
3. incorporation of RAMS minute tapes into the trajectory model
4. use of the trajectory model in the calculation of 50 specific air parcel paths
5. description of the meteorology involved in each of the 50 calculated trajectories
6. and assessment of the accuracy of the trajectory results

SUMMARY OF RESULTS

Fifty near-surface air parcel trajectories were derived by EQR using their in-house, objective Model. The times and other specifications were provided through close cooperation with the teams of scientists involved in the Intensive air pollution samplings and with EPA supervisory personnel.

Table 1 briefly details the trajectory type, time, and location. The results are provided in both pictorial and tabular format. The cases are described meteorologically and the sources of errors estimated. It is also shown that most trajectory calculations are valid in the surface boundary layer within 10% limitations in both direction and speed.

---

*Proprietary computer software

TABLE 1. A DESCRIPTION OF THE TYPE, TIME, AND LOCATION OF THE 50 TRAJECTORIES

Date	Locations	Type	Times (CST)	Number of Trajectories
7/17/75	RAMS 106, 111, 105, 104, 102, 108, 121, 122, 123	Backward	2000	9
7/18/75	RAMS 106, 111, 105, 104, 102, 108, 121, 122, 123	Backward	0800	9
7/22/75	14th & Market, Broadway & Hurck	Backward	1900, 2300	4
7/23/75	14th & Market, Broadway & Hurck	Backward	0300, 0700, 1100, 1500, 1900, 2300	12
7/24/75	14th & Market, Broadway & Hurck	Backward	0300, 0700, 1100, 1500, 1900, 2300	12
8/8/75	RAMS 111	Foreward	1000	1
8/11/75	KETC-TV TOWER	Foreward	1000	1
8/13/75	WEBSTER COLLEGE	Foreward	2000	1
8/15/75	RAMS 111	Foreward	1000	1
			TOTAL	50

SECTION 2

CONCLUSIONS

On the basis of work reported here, it is concluded that:

1. The in-house trajectory model is adaptable to a large number of data analysis tasks that are of immediate utility to field investigations conducted in the St. Louis area during periods when RAMS minute data has been archived.
2. The use of RAMS minute data to construct near-surface trajectory estimates may be made an operational aspect of the model, and results in a detailed description of the urban wind field with an accuracy comensurate with the intrinsic limitations imposed by pointwise data.
3. The various scales of applicability for the trajectory product within the RAMS network necessitates either 15-minute averaging or the corrected use of the 1-minute values. The former is employed in the regional and metropolitan scale and the latter is utilized in the metropolitan and urban scales of the model.
4. A simple inverse area smoothing technique, involving at least a 10 kilometer radius about the air parcel location and a minimum of two stations, is the best choice among other more complicated techniques due to cost considerations and universality of applicability.
5. Trajectory paths of 6 hours or longer often exhibit changes in direction and speed during the summer months due to the passage of meteorological wind perturbations produced by convective activity and other diurnal effects. Trajectories produced by 1-minute stepping show the real effects of turbulence and roughness perturbations. These fluctuations are apparant in the 1-minute data at each station but their application in area averaging to represent winds elsewhere is still speculative.

6. The trajectory model optimizes the usage of RAMS surface wind data in the production of near-surface air parcel motion. The model can be modified to accept observations on any time or distance scale.
7. The air parcel paths simulated by the Contractor's in-house trajectory algorithm are accurate within the tolerances ascribed to the temporal and spacial representativeness of observed data.

SECTION 3

RECOMMENDATIONS

The processing of 50 near-surface urban-scale trajectory estimates using RAMS wind data has provided a first exploration into the utilities and capabilities of the Contractor's trajectory model for application to special investigation periods during the RAPS program. Based on the insights and experience gained, it is strongly recommended that further work in the following areas be undertaken:

1. All past RAPS intensive periods of scientific investigation in the St. Louis area be made the subject of trajectory calculations.
2. Within each period of RAPS intensive investigation the sites for the various experiments should be listed as end points (or air parcel origins as in the case of tracer releases) for trajectory calculations.
3. Rectangular grid of end points should be designated for which periodic trajectory calculations will be calculated during the RAPS intensive periods.
4. Computations be made comparing vorticity and divergance derived from these trajectory patterns to those made from conventional analysis of wind data. Differences should be attributable to the time rate of change of the wind pattern.
5. Studies be undertaken to correlate known sources of pollution emissions to their progression downwind past the RAMS monitoring networks. Time sequences of foreward trajectories originating from these known sources will give the supposed arrival times of pollution "plumes". Peaks in concentrations will document the arrival and will indicate the validity of the trajectory results for various meteorological conditions.

6. Efforts be made to incorporate vertical profiles of wind speed and direction into trajectory calculations for distinct levels in the lower boundary layer.
7. Additional trajectories be run for the tracer studies of Dr. Frederic Shair so that a succession of air parcel paths origination during the entire period that SF_6 was released. A succession of trajectories will help to distinguish the horizontal speed of tracer materials from advective rather than dispersive processes.
8. More testing of the trajectory model incorporating 1-minute RAMS data be documented.
9. Studies be made of severe weather conditions in the urban area by evaluating the confluence and divergence patterns of simultaneous trajectory patterns.
10. Studies be made of stagnant wind conditions in the urban area through the use of simultaneous trajectories to evaluate the buildup and transport of locally produced pollution.
11. Determination of the sources of large scale high pollution episodes be attempted using the trajectory model and surface wind data commensurate with the scale of air parcel travel over the period of 4 to 7 days.
12. Preplanning of future studies to incorporate the use of trajectories in an operational and post-analysis mode.
13. Future surface data networks be linked directly to the trajectory model as a part of an instant analysis scheme. An enormous quantity of unanalyzed meteorological and air quality data exists not only after the three years of RAMS data collection in the St. Louis area but from hundreds of scientific experiments in which thorough meteorological post-analysis has been omitted. The trajectory model has the potential to be a powerful tool in the examination of the physical environment in which scientific research has taken place. Other significant meteorological aids, possibly even in the forecast mode, may be derived as continued research is undertaken to expand the utility of the trajectory product.

SECTION 4

RAMS DATA SOURCE

RAMS DATA NETWORK

The Regional Air Pollution Study for St. Louis, Missouri was initiated in 1973. A Regional Air Monitoring System (RAMS) was constructed to measure surface air quality and meteorological data. Twenty-five RAMS sites continually monitor the environment of St. Louis, Missouri, which has given the urban scale meteorologist an opportunity to scientifically examine air parcel trajectories. Data from this system is to be utilized by scientists and principal investigators as part of the Regional Air Pollution Study (RAPS).

The region covered by RAMS is pictured in Fig. 1. The 25 automatic air quality monitoring sites are concentrically spaced, extending outward to a distance of 30 miles. Average station separation distance is about four miles within a ten mile diameter of downtown St. Louis. The outer four RAMS stations are approximately ten miles beyond the neighboring ring of stations. Table 2 describes each station's location.

The station data is recorded on magnetic tape on a continuous basis at a central location in Creve Coeur, Missouri. The data is validated and archived in Research Triangle Park, North Carolina.

The 24 parameters listed in Table 3 are converted into both 1-minute and 1-hour averages. The 1-minute data are used in urban trajectory calculations. The RAMS instrumentation list is given in Table 4.

The wind speed and direction sensors are accurate to .06 meters per second (or 1% of the wind speed whichever is higher) and 2 1/2° within a range of .3 to 54 meters per second according to factory specifications. Continuous analog averaging of the wind speed and direction for 60 seconds constitutes the data recorded on the RAMS minute tapes. Hour averaged RAMS tapes contain wind data that are vectorially averaged from the minute data.

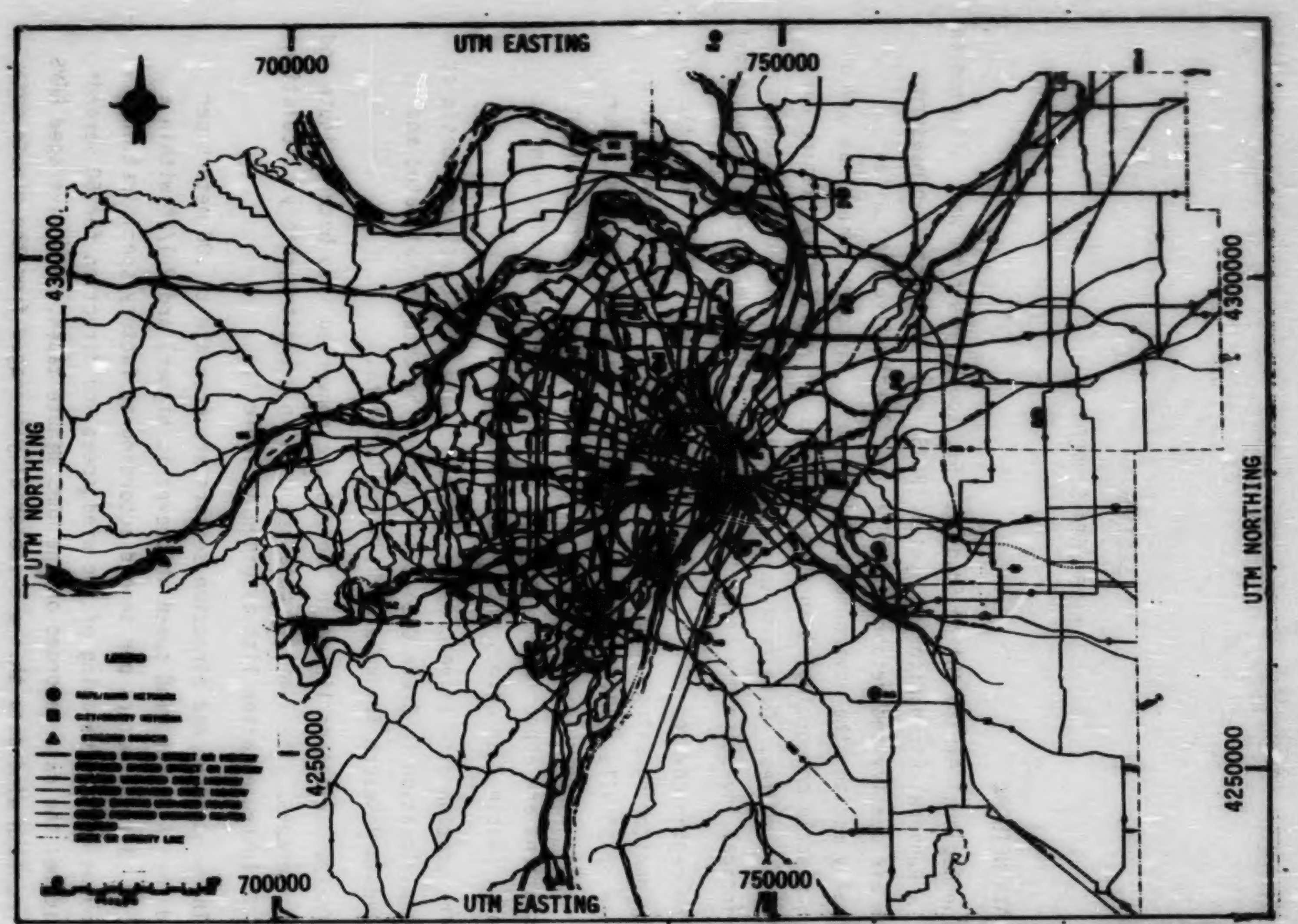

UTM EASTING
700000
750000
UTM NORTHING
4300000
4250000

FIGURE 1. THE METROPOLITAN AREA COVERED BY THE REGIONAL AIR MONITORING NETWORK (RAMS) SURROUNDING ST. LOUIS, MISSOURI

TABLE 2. A LIST OF THE LOCATIONS OF THE 25 RAMS STATIONS AND THE LOCATION OF THE FOUR ADDITIONAL RADIOSONDE SITES USED TO PRODUCE VERTICAL WIND PROFILES

SITE	LATITUDE	LONGITUDE	UTM (ZONE 15) NORTHING	UTM (ZONE 15) EASTING	ELEVATION
RAMS 101	N 38° 38'08"	W 90° 11'41"	4,279,862m	744,183m	145m
RAMS 102	N 38° 41'30"	W 90° 12'42"	4,286,045m	742,518m	128m
RAMS 103	N 38° 39'29"	W 90° 09'17"	4,282,467m	747,588m	127m
RAMS 104	N 38° 36'42"	W 90° 09'35"	4,277,304m	747,312m	124m
RAMS 105	N 38° 36'18"	W 90° 12'05"	4,276,453m	743,706m	131m
RAMS 106	N 38° 36'59"	W 90° 15'32"	4,277,566m	738,660m	150m
RAMS 107	N 38° 39'41"	W 90° 14'23"	4,282,610m	740,179m	158m
RAMS 108	N 38° 44'08"	W 90° 08'32"	4,291,102m	748,407m	130m
RAMS 109	N 38° 37'57"	W 90° 03'41"	4,279,886m	755,802m	127m
RAMS 110	N 38° 34'17"	W 90° 09'45"	4,272,826m	747,209m	126m
RAMS 111	N 38° 34'14"	W 90° 15'32"	4,272,479m	738,812m	134m
RAMS 112	N 38° 38'52"	W 90° 18'43"	4,280,913m	733,938m	170m
RAMS 113	N 38° 43'37"	W 90° 15'55"	4,289,820m	737,738m	174m
RAMS 114	N 38° 47'38"	W 90° 11'13"	4,297,456m	744,320m	162m
RAMS 115	N 38° 47'36"	W 90° 02'23"	4,297,799m	757,111m	134m
RAMS 116	N 38° 43'20"	W 89° 58'39"	4,290,083m	762,777m	172m
RAMS 117	N 38° 34'03"	W 90° 00'34"	4,272,818m	760,560m	177m
RAMS 118	N 38° 29'11"	W 90° 12'48"	4,263,256m	743,065m	155m
RAMS 119	N 38° 33'20"	W 90° 21'48"	4,270,547m	729,759m	159m
RAMS 120	N 38° 41'44"	W 90° 26'06"	4,285,909m	723,079m	168m
RAMS 121	N 38° 50'29"	W 90° 19'20"	4,302,376m	732,414m	174m
RAMS 122	N 39° 04'50"	W 90° 12'24"	4,329,223m	741,631m	180m
RAMS 123	N 38° 41'04"	W 89° 48'43"	4,286,378m	777,320m	143m
RAMS 124	N 38° 14'39"	W 90° 09'06"	4,236,537m	749,275m	207m
RAMS 125	N 38° 40'07"	W 90° 43'50"	4,282,240m	697,445m	187m
UAN 141	N 38° 37'43"	W 90° 12'33"	4,279,053m	742.949m	149m
UAN 142	N 38° 31'15"	W 90° 35'56"	4,266,130m	709,270m	179m
UAN 143	N 38° 25'32"	W 90° 01'06"	4,257,038m	760,290m	176m
UAN 144	N 38° 53'10"	W 90° 03'01"	4,308,067m	755,861m	166m

TABLE 3. A LIST AND DESCRIPTION OF THE 24 PARAMETERS MEASURED BY THE RAMS NETWORK

NO	PARAMETERS	SYMBOL (UNITS)	STATIONS
1	WIND SPEED	WS (m/sec)	ALL
2	WIND DIRECTION	WD (° OF AZIMUTH)	ALL
3	TEMPERATURE	T (°C)	ALL
4	DEW POINT	DP (°C)	ALL
5	BAROMETRIC PRESSURE	BP (inches of Hg) at station height	101,109,112, 122-125
6	DELTA TEMPERATURE	DT (°C)	101,102,104-107, 109,111-113,122, 123
7-9	PYRANOMETER	PYRA (CAL/CM^2-MIN)	103,104^t,108^t,114 118,122
10	PYRGEOMETER	PYRG (CAL/CM^2-MIN)	103,114,118,122
11	OZONE	O_3 (PPM)	ALL
12	CARBON MONOXIDE	CO (PPM)	ALL
13	METHANE	CH_4 (PPM)	ALL
14	TOTAL HYDROCARBON	THC (PPM)	ALL
15	NITRIC OXIDE	NO (PPM)	ALL
16	NITROGEN DIOXIDE	NO_2 (PPM)	ALL
17	OXIDES OF NITROGEN	NO_x (PPM)	ALL
18	TOTAL SULFUR	TS (PPM)	ALL
19	HYDROGEN SULFIDE	H_2S (PPM)	101,103-106,108, 113-116,120-122
20	SULFUR DIOXIDE	SO_2 (PPM)	same as H_2S
21,22	NEPHELOMETER (HEATER OFF-ON)	NEPH	ALL
23,24	PYRHELIOMETER	PYRO (CAL/CM^2-MIN)	103,114,118,122

( )^t- hour tapes only

TABLE 4. A LIST AND DESCRIPTION OF THE INSTRUMENTATION USED TO DETERMINE EACH PARAMETER MEASURED BY THE RAMS NETWORK

O_3-Monitor Labs 8410	Stations 101-105
NO-NO_x Monitor Labs 8440	Stations 101-105
CO-CH_4-THC Beckman 6800	Stations 101-105
TS-SO_2-H_2S Tracor 270HA	Stations 101, 103-106, 108, 113-117, 120-122
TS-Meloy SA 185	Stations 102, 107, 109-112, 117-119, 123-125
Visibility-MRI 1561	Stations 101-125
Wind Speed-MRI 1022 S	Stations 101-125
Wind Direction-MRI 1022 D	Stations 101-125
Temperature-MRI 840-1	Stations 101-125
Dew Point-Cambridge 880	Stations 101-125
Temp. Gradient-MRI 840-2	Stations 101-102, 104-107, 109, 111-113, 122-123
Barometer-Sostman 363	Stations 101, 109, 112, 122-125
Solar Pyranometer	Stations 103-104, 108, 114, 118, 122
Radiation Pyrheliometer	Stations 103, 114, 118, 122
(Eppley) Pyrgeometer	Stations 103, 114, 118, 122
Turbulence-R.M. Young 27002	Stations 105, 107, 109, 111, 113
Gas Bags-Xonics	Stations 101-125
Hi-Vol, Sierra 305	Stations 103, 105-106, 108, 112, 115, 118, 120,122,124
LBL Dichotomous Sampler	Stations 103, 105-106, 108, 112, 115, 118, 120,122,124

Since the minute averages are not computed vectorially, the calculated wind speed could be as much as a factor of 2 too high during turbulent regimes where the wind direction is extremely variable.

DATA VALIDATION

Meteorological and air quality data that are suspected to be invalid are flagged in one of several ways according to the most current validation scheme (Version 4).

Missing Data

If any of the 24 parameters are missing, a value of 10^{37} is put in position as a replacement. This can occur due to any number of conditions that produce equipment outage. When a station is powered down, all 24 channels will be missing and will be assigned to the 10^{37} category. Once a day, near midnight (local 2400), data storage tapes are changed at RAPS headquarters and several minutes of data are lost for all stations.

Status Errors

An auxiliary channel of input is produced to indicate proper operation or status of the instrumentation. If this check is positive, the data being generated is declared invalid and is multiplied by 10^{25}.

Excessive Drift

The current version of the validation scheme does not correct for machine zero drift. A catalogue of drift values is currently being processed. Parameters that exceed drift limits are left unchanged.

Lower Detectable Limits (LDL)

All output that is below the LDL is converted to a value of one half the LDL. This criteria varies for the different parameters as follows:

LDL = ± .005 PPM for O_3, NO, NO_2, NO_x, SO_2, H_2S, and TS
LDL = ± .100 PPM for CO, CH_4, THC
LDL = 10^{-4} for the nephelometer

Gross Limit

Each parameter has a reasonable limitation on the high side which is determined by the nature of the variable. When this value is exceeded the data is converted to 10^{34}.

Relational

Several correlations between chemical parameters exist and, if violated, the variables that are invalid are multiplied by 10^{32}. The relationships checked are as follows:

1. $(\text{Dewpoint} - 0.5) < \text{Temperature (in °C)}$
2. $\text{Pyranometer \#1} > \text{P\#2} > \text{P\#3}$

   $$.90 \leqslant \frac{\text{Pyranometer \#2}}{\text{P \#1}} \leqslant .98$$

   $$.40 \leqslant \frac{\text{Pyranometer \#3}}{\text{P \#1}} \leqslant .60$$
3. $.50 \leqslant \frac{\text{Pyrgeometer}}{T^4} \leqslant 1.1$
4. $(NO)\cdot(O_3) < .04$
5. $\frac{CH_4 - THC}{CH_4} < .2$
6. $NO_x - NO > 0$
7. $SO_2 + H_2S < TS$

Constant Data

If parameters are within limits but do not change in value over a ten minute period, they are flagged by multiplying them by 10^{23}.

Inter-station Checks

If variables are within limits but are suspicious when compared to other station data, the values are multiplied by 10^{14}.

RAMS DATA RETRIEVAL

On a daily basis RAMS data tapes are sent to Research Triangle Park, North Carolina, for validation and storage. Data can be retrieved within a month's time in either minute or hour averaged format. Some problems occured in the conversion of the RAMS data from UNIVAC to IBM compatibility. Data processors at RTP produced an IBM binary Tape for EQR, the first of its kind to be disseminated to research users. Currently 5 tapes, consisting of 10 days of minute RAMS data each, have been sent to EQR in IBM compatible format covering the period from July 3, 1976 to August 22, 1976. The turn-around time for data retrieval from RTP for the latest tape took less than 2 weeks. Coordination supplied by Robert Jurgens, RTP Data Manager, has been excellent.

SECTION 5

TECHNICAL APPROACH

THE TRAJECTORY PROGRAM

Environmental Quality Research, Inc. during the Summer of 1973 constructed an in-house computer simulation Model* to calculate both forward and backward trajectories given suitable wind data within the grid covered by the trajectory. This model inputs RAMS minute wind data including records of up to 12-hour periods.

The basic program is depicted in Figure 2. Two iterative loops complicate the basic logic. The first, labeled A, is executed every time another 15-minute trajectory step is calculated. The number of steps is determined by the amount of hours of data inputed or by the position of the trajectory point if it is still within the boundaries predetermined for the trajectory. The second loop, labeled B, is executed every time the iterated trajectory position is not within a prescribed distance of the previous calculation. Steps sublabeled A are executed A times. Steps sublabeled AB are executed the product of A and B times.

The more detailed functions of each subroutine are described in Table 5. Many of the products of the trajectory program are checks of inputs and of calculations. Most of outputs are eliminated during actual program use to reduce program costs. The primary outputs are:

a. The 15-minute wind average from all 25 RAMS stations are all input data (usually 12 hours). (from WINDAV)
b. The summary page of trajectory calculations (from OUT)
c. The Calcomp plot of the trajectory steps down to a scale to fit a predrawn St. Louis grid (from PLOTER).

The trajectory program can be run for an unlimited number of trajectories using the same data base. This outside loop is not indicated in Fig. 2.

---

*Proprietary

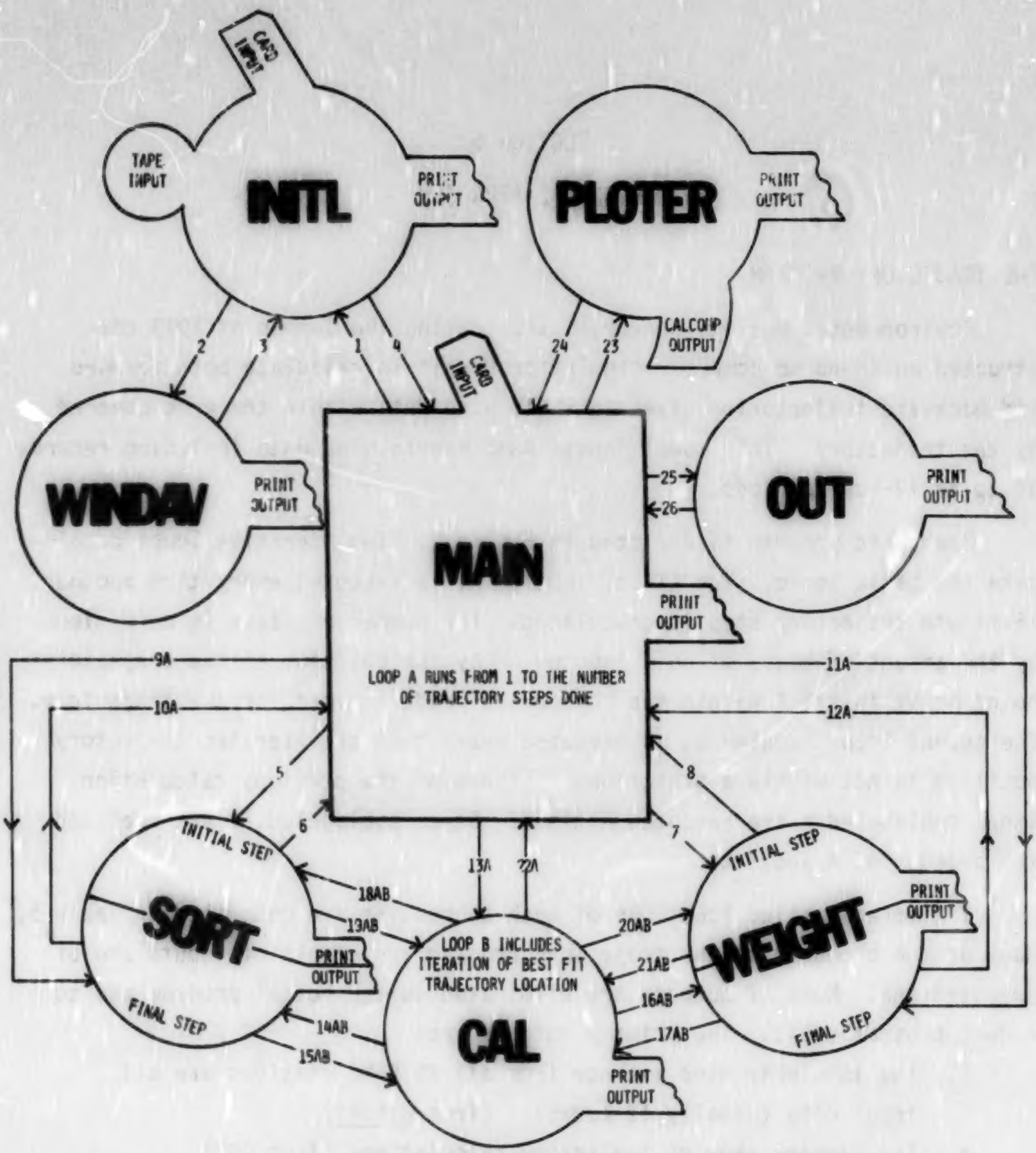

CARD INPUT
TAPE INPUT
INITL
PRINT OUTPUT
PLOTER
PRINT OUTPUT
CALCOMP OUTPUT
2
3
1
4
24
23
CARD INPUT
WINDAV
PRINT OUTPUT
MAIN
25
26
OUT
PRINT OUTPUT
PRINT OUTPUT
9A
10A
11A
12A
LOOP A RUNS FROM 1 TO THE NUMBER OF TRAJECTORY STEPS DONE
5
6
8
7
13A
22A
INITIAL STEP
SORT
PRINT OUTPUT
FINAL STEP
18AB
13AB
14AB
15AB
LOOP B INCLUDES ITERATION OF BEST FIT TRAJECTORY LOCATION
CAL
PRINT OUTPUT
20AB
21AB
16AB
17AB
INITIAL STEP
WEIGHT
PRINT OUTPUT
FINAL STEP

FIGURE 2. A FLOW CHART DESCRIBING THE BASIC LOGIC OF THE EQR IN-HOUSE, OBJECTIVE TRAJECTORY PROGRAM UTILIZING RAMS 1-MINUTE DATA FOR THE CALCULATION OF ONE COMPLETE TRAJECTORY.

TABLE 5. SPECIFICATION OF SUBROUTINE TASKS IN THE CONTRACTOR'S IN-HOUSE, OBJECTIVE TRAJECTORY PROGRAM

Subroutine	Function
1. Main Program	1. Call for input data [to subroutine INITL (step 1), return (step 4)].
	2. Reads in grid fixing coordinates.
	3. Controls calculation of first trajectory step estimate [to subroutine SORT1 (step 5), return (step 6)], [to subroutine WEIGHT1 (step 7), return (step 8)].
	4. Loop A controls cycling through each trajectory step using 15-minute wind averages in chronological order. [to SORT2 (step 9A), return (step 10A)], [to WEIGHT2 (step 11A), return (step 12A)], [to CAL (step 13A), return (step 22A)].
	5. Checks to see if trajectory has exited the grid boundaries.
	6. Calls plotting subroutine [(to subroutine PLOTER (step 23), return (step 24)].
	7. Calls final printout routine [to subroutine OUT (step 25), return (step 26)].
	8. Concludes program after making a check to see if another trajectory is to be calculated using the same wind data.
2. Subroutine INITL	1. Reads in trajectory start and end time and prints it out.
	2. Reads in indicator for 15-minute input or 1 minute input (standard RAPS input) and prints it.
	3. Reads in indicator for how many 4 minute block of RAPS data will be read in (if applicable) and prints it.

(continued)

TABLE 5 (continued)

	4. Reads in indicator for foreward or backward trajectory and prints it.
	5. Reads in indicator of how many 4-minute blocks will be passed over in a 2-hour file to start at the correct time and prints it.
	6. Reads indicator of how many minutes to skip within a 4-minute block to start on time and prints it.
	7. Reads indicator which controls printing of all 15-minute averages generated and prints it.
	8. Reads indicator which controls printing of all intermediate trajectory calculations and prints it.
	9. Defines the number of stations.
	10. Defines subscripts for 15-minute averages and for data read in.
	11. Defines the size of the circle around each trajectory location within which averaging takes place.
	12. Reads in station locations (UTM coordinates).
	13. Inputs all raw wind speed and direction.
	14. Throws out all wind data outside of limits and assigns it a constant value.
	15. Controls calculation of 15-minute averages [to subroutine WINDAV (step 2), return (step 3)].
	16. Reads in data to throw out 15-minute averages if suspect data is on RAMS minute tape.
	17. Prints 15-minute averages for all stations.
3. Subroutine WINDAV	1. Calculates vector 15-minute wind aver-

(continued)

TABLE 5 (continued)

	ages and prints them.
4. Subroutine SORT	1. Calculates distance between trajectory location and all stations. 2. Prints trajectory locations. 3. Prints the distance between station and each trajectory location. 4. Arranges all distances in ascending order. 5. Determines how many stations are within a prescribed distance of the trajectory location.
5. Subroutine WEIGHT	1. Calculates weighting factor for each station's wind in calculation of average wind at the trajectory location and prints it. 2. Calculates wind speed direction at trajectory location.
6. Subroutine CAL	1. Calculates x and y positions for trajectory for each step. 2. Calculates the first estimate of a trajectory location for each step. 3. Calls sorting and weighting in the interaction of the fine tuning of each trajectory step, [to subroutine SORT2 (step 14AB), return (step 15AB)], [to subroutine WEIGHT2, (step 16AB), return (step 17AB)]. 4. Calculates distance between last and next estimate of the trajectory position and reiterates if it is too large. 5. Prints the distance between last and next trajectory step during iteration. 6. Computes speed and direction between last 2 trajectory positions.

(continued)

TABLE 5 (continued)

	7. Prints trajectory speed and direction average at the initial and final points of the step. 8. Prints trajectory speed and direction average at the initial and final points of the step. 9. Prints the past and new trajectory location in kilometers from (0, 0) start. 10. Prints the final step location in UTM coordinates. 11. Calls sorting and weighting for the first estimate of the next trajectory step, [to subroutine SORT1, (step 18A), return (step 19A)], [to subroutine WEIGHT1 (step 20A), return (step 21A)].
7. Subroutine PLOTER	1. Defines plotter coordinates. 2. Calculates start and end time in hours and minutes of trajectory. 3. Calcomps header for final output. 4. Calcomps locator stations on the plot. 5. Plots trajectory locations on final output each 15 minutes. 6. Prints out plotter coordinates and trajectory locations.
8. Subroutine OUT	1. Prints a one page summary of all trajectory steps coordinates. 2. Prints time and day headers on summary page. 3. Calculates and prints radial distance between steps and for cumulative trajectory and speed and direction of each step and cumulative on summary page.

THE USE OF RAMS 1-MINUTE DATA

As described in Table 3, the RAMS minute data tapes contain meteorological and air quality data. The trajectory program requires the surface wind data from the 25 RAMS stations listed in Fig. 1. The wind data is continuously sampled, however the minute data is not vectorially averaged. The instrumentation (model MRI-1022) is located on towers 30 meters in height for most sites, except for stations 108, 110, 114-118, and 121 where 10 meter towers are utilized.

The non-uniformity of sensor placement causes some disparity in wind speed results which will be discussed in more detail in the project results section. All wind speeds and directions are adjusted to some representative height for which the trajectory calculation is derived. (Karl, 1976).

The parameters listed in Table 6 describe the minute RAMS tapes as

TABLE 6. DESCRIPTION OF THE DATA CONTENT IN EACH 4 MINUTE BLOCK OF THE RAMS 1-MINUTE TAPE.

Word	Value	Type
3	Time (LST)	INTEGER
4-27	parameters of Table 3. station 101, above Time	REAL
28-51	same for station 102	"
.	.	
.	.	
.	.	
579-503	same for station 125	"
504-628	parameters for station 101	"
.	.	
.	.	
.	.	
2379-2403	parameters for station 125 Time + 3 minutes	Real

archived by RTP for each 4 minute block of data. The entire block is read in alphanumeric (ID(2403)) and is equivalenced to a real variable. The first three variables represent the year, Julian date, and the hour and minute of the first of the four minutes of data. Thirty reads of the tape are required to encompass one file of data. These two hour files were packed on a 2400 feet magnetic tape reel to include 10 days or 120 files of data.

The first three integer values read are used to control the search for the correct wind data to be used in the trajectory calculation. Additional data are read into the program on cards.

The first of these card data is the trajectory end or start time depending on which is fixed in the problem. The time of the unspecified trajectory endpoint is calculated by the program.

A second variable read in on cards determines how much data on the tape is passed over to arrive at the wind data that must correlate with the time of the trajectory. Any file can be accessed. Accessing file 13 on the tape means that 12 files are automatically skipped. Since these 12 files contain 24 hours of data the first wind data in the 13th file contains values for hour 00 and minute 00 of the second day out of ten in the tape. Selecting the correct files allows one to pass through the tape, bypassing unnecessary data, and to start within two hours of the any prescribed time.

A third variable is read in to specify the number of "dummy" reads needed to focus in on the predetermined initial minute of wind data. A fourth indicator is read in and determines how many minutes to skip within a four minute block to start reading exactly on time.

The trajectory program is designed to accept up to 12 hours of RAMS minute data the last of which is used as the read cut-off point unless the trajectory has been limited for some other reason. All 25 stations are utilized in the trajectory calculations even if one of the stations has some or all of its data missing.

To conserve program space the wind data is averaged in blocks as the minute data is read into the program. The space allocated for bulk data input is refilled once each set of wind data is averaged. The wind averaging is usually performed over a 15-minute period but this can be varied.

CALCULATING A TRAJECTORY

The first step in trajectory calculation is to determine the extent of RAMS minute data that will encompass the entire trajectory. Usually the trajectory's initial location and time and final time are specified. When the length in unknown, up to 12 hours of 15-minute wind averages can be utilized for all 25 stations.

Once the wind speed and wind direction are averaged, this determines the time step involved in each trajectory step, (i.e., 15-minute averaged winds are used to produce trajectories with fifteen minute time increments). The steps involved in calculating a trajectory using 15-minute averaged winds are as follows:

1. Determine the average wind speed using wind data from as many stations as necessary at the initial point of the trajectory for time (t_0).
2. Calculate how far the air parcel would move from the initial point in fifteen minutes at the speed and direction of the average wind. Define this new point x_1.
3. Determine a new average wind, centered about a time 15 minutes later than the first average in the vicinity of the new point x_1.
4. Calculate how far the air parcel would move from point x_1 in 15 minutes at the new average speed and direction. Define this new point x_2.
5. These steps are continued until either the prescribed length of time has expired, until wind data is no longer available, or until the trajectory point has gone as far as is necessary.

Details in the wind averaging will be defined in later sections.

RECYCLING TO ACHIEVE CONVERGENCE FOR STEP ACCURACY

In the true trajectory the wind speed and direction are changing instantaneously at each point of the path taken by the air parcel. Accuracy in a calculated trajectory is usually achieved by decreasing the increment of the true step so that the wind averages better represent the instantaneous wind so that the accumulated error along the trajectory path is reduced. Later sections will discuss some results of reducing the time step.

It was found that the basic methodology described previously diverges rapidly from the true solution toward the end of the trajectory. The source of the error is the following:

> The average wind defined at the initial location is not valid either at the time of or at the location of the next trajectory step. Moving the air parcel for 15 minutes for a constant speed and direction defined by the initial time and location makes the air parcel diverge tangentially from the true solution. It is not long until neither the speed nor direction used in the calculations is representative and the rate of divergence increases.

An almost complete solution to the problem is to define the average wind for both ends of the trajectory step, then average vectorially, and move from the first location with this averaged speed and direction. This direct approach is complicated by the fact that the average wind at the endpoint can't be calculated until that end point is calculated.

However by a process of iteration this solution can be approached. The methodology is exactly as described in the previous section through step 3. The approach is given below:

1. Determine the average wind speed using wind data from as many stations as necessary at the initial point x_0 of the trajectory for time t_0.
2. Calculate how far the air parcel would move from the initial point in 15 minutes at the speed and direction of the average wind. Define this new point x_1.
3. Determine a new average wind centered about a time 15 minutes later than the first average in the vicinity of the new point x_1.
4. The average wind speed at t_0 and t_1 are combined to derive a wind speed more representative along the path from x_0 to x_1.
5. Step 2 is repeated using the new average wind and a new trajectory location x_1 is defined.
6. The two values of x_1 are compared, the latter one being more correct. If the amount of correction has been insignificant the latter value of x_1 is accepted and step 1 is repeated for the point x_1 at time t_1.
7. If the difference between the two calculated values of x_1 exceeds

some limit, then a new average wind is calculated at the latest x_1 location at time t_1.

8. Winds at x_0 and x_1 are then reaveraged and a new step location x_1 is found. This iteration is repeated until successive values of x_1 are within acceptable limits.

For the trajectories presented in this report in Section 8 the limit was defined as a one meter difference between iterations. The method usually converged within five repetitions. Keeping this error below one meter of each 15 minute step ensures the accuracy of the method even for trajectories up to 12 hours in length.

AVERAGING RAMS NETWORK WIND DATA AT EACH TIME STEP

Wind averaging must be accomplished since none of the RAMS surface wind data is representative of the moving air parcel. Each station is affected by the nature of the topography, the height and thickness of the surrounding tree cover, and the positioning and geometry of the neighboring buildings. It is very unlikely that any station's wind data are undisturbed and that none are really representative of the true flow at that location.

There are several techniques that can be used to produce an averaged wind, but they are admittedly subjective in their final applications.

1. The number of stations used to create an average "representative" wind should increase if either the wind data are unreliable or if a larger scale application is to be used.
2. The number of stations used in the average may be fixed if the stations are more or less equidistant or they may be variable so as to cover approximately equal area coverage if the stations are randomly dispersed.
3. The wind data from each station may be weighted to incorporate either reliability or closeness of the station to the point of application of the average.

The trajectory model derives as close to real air parcel paths as can be determined for an urban environment using a mesoscale network of wind monitors. As can be seen from Fig. 1 the network of 25 stations is not equally spaced. Therefore the first modification in the program was to define some radius around the trajectory location within which a search of wind data would be undertaken to derive a representative mesoscale wind average for that location.

The trajectory model currently utilizes a value of 10 kilometers (~6 miles) as an averaging circle. This circle contains up to six stations when the trajectory is located in the denser urban network and theoretically none when the parcel passes the fringe of the network. The reasoning behind the 10 kilometer limiting circle is that certain data are too far away to be applied in any degree to the wind average at some trajectory locations. Often the urban wind field is disturbed by a real phenomenon especially with light winds or during unstable convective situations and utilizing too much wind data contaminates the results.

A more serious problem is encountered as the trajectory passes through the extremity of the data network since the data to be averaged is reduced to zero. A check is made in the program to keep at least two stations in the averaging circle. This is accomplished by incrementing the circle's size by another 10 kilometers and redetermining the number of stations in the new circle. In this manner the trajectory moves past the last stations of the network always using the data from at least two stations. It is obvious that an extrapolative procedure such as described above is only approximately valid and necessitates that the data in the periphery of the data network be areawise representative.

Within the averaging circle of 10 kilometers the wind data is weighted according to the relative distances the stations are from the point of application of the average wind. On the belief that any wind observation may not be totally representative, the weighting of data at the center of the 10 kilometer circle is only twice that of data at the edge of the circle. This is done by assigning a weighting equation as follows:

$$\text{wind(1) weighting} = \frac{1}{\text{distance} + 10}$$

where distance is the separation between station(1) and the trajectory location in kilometers. This ratio varies between a value of 1/10 to 1/20.

Each wind weighting is normalized by dividing the weighting factor by the sum of all the weighting factors. For example if 5 wind sets are located 1, 5, 3, 8, and 0 kilometers from the trajectory location, the corresponding weighting factors are .263, .193, .223, .161, and .289. The sum of the weighting factors is 1.000 so that the vectorially averaged wind is the sum of each station's wind components multiplied by its appropriate weighting factor.

MISSING DATA

It is not uncommon that a majority of the wind data from any RAMS station be invalidated for a 15 minute period. As was discussed previously, missing data, as well as invalidated data, are denoted appropriately by flagging procedures. Wind speed and wind direction are flagged separately and only one or the other may be invalidated. However, vectorially averaging requires that both wind speed and direction must be validated. The flagging procedure forces the data out of normal range. The trajectory program makes two checks, either of which can define the particular minute of data as missing. The two checks for good data are:

1. $0 \leqslant$ wind speed $\leqslant$ 25m/sec
2. $0 \leqslant$ wind direction $\leqslant 360°$

If either of these checks is violated the wind speed and direction are set to 99. In the construction of 15 minute averages a majority of the 25 RAMS stations were found to produce some missing wind data. If even one minute of data was reported during the 15 minutes, then the average wind was calculated. Stations that did not report any valid data were assigned speeds and directions of 99.

In the wind averaging section of the trajectory program the distance between the present parcel position and each of the 25 stations is calculated. All the wind data are listed in order of increasing distance. Stations that have missing 15-minute averages are defined as being 99.999 km from the air parcel. This ensures that the stations with missing wind data are last when they are arranged by increasing distance.

At each trajectory location all stations falling within the 10 kilometer circle are used in the averaging. If less than two are found, then increments of 10 kilometers are added until at least two stations can be utilized in the averaging. If two stations cannot be found with validated data, then as an approximation, the data for the previous 15 minute averages are used.

SECONDARY WIND VALIDITY CHECKS

One of the program options is the printing of all 15-minute averages derived to accomplish the trajectory. The program maximum includes twelve hours of wind data or 48 15-minute averages. The time sequence of these wind averages as well as their spacial comparison allow the user to effectively judge the validity of even the data that falls within the standard ranges of valid data but may be distorted by some minor malfunction. Four procedures were routinely followed to minimize the inclusion of spurious data which might cause the trajectory to diverge from its true path.

1. The printouts of the fifteen minute averages for each station are visually inspected to see that normal meteorological continuity is maintained. Mesoscale weather phenomenon that produce wind changes will affect several 15-minute averages at each station and will move systematically through the RAMS network.
2. The fifteen minute averages are plotted spacially to produce an interstation relational check. Streamlines are drawn over the network using all available good wind data.
3. Maps of 15-minute plotted winds are compared for various time periods to ensure discontinuity of suspected anomalies.
4. Various derived conservative products, such as vorticity, divergence, and their time rate of change are also plotted spacially and examined for continuity.

On the above basis several fifteen minute averages are usually declared invalid and cards are read into the program setting these wind speeds and directions to 99. Conversely, to provide a more sound base for trajectory calculations the above four checks for data continuity can be used to give reasonable estimates of missing or suspect data. These estimates can be also entered in card form, taking precedence over the already computed 15-minute averages.

FOREWARD AND BACKWARD TRAJECTORIES

In the Introduction many of the uses of air parcel tracing are alluded to, but all fall into two basic categories: foreward trajectories and backward trajectories. The following is a brief description of each:

1. Foreward Trajectory: the path taken by a parcel of air starting at some fixed location and time as it travels to some later place and time.
2. Backward Trajectory: The path taken by a parcel of air that has arrived at a fixed location and time as its movement is retraced to an earlier place and time.

More frequently the wind is thought of as a carrier of some physical parameter such as chemical stack emissions, clouds, or even conservative properties of the air itself.

In application, if a source emission is being studied, both types of trajectories can be utilized. The source location and time of emission can be fixed so that the foreward trajectory of the pollutant can be followed to some point and time downstream. Conversely, for the same situation, if some downwind monitor picks up a high concentration of the particular pollutant, a backward trajectory can be followed upwind from the receptor coordinates at a fixed time to see if any known source of the pollutant lies along the path.

The trajectory program incorporates card read-ins that define whether the trajectories will proceed forward or backwards in time. Also the source or receptor location is entered, both by name and by UTM coordinate. The time that the trajectory is to begin is also entered by card and determines the wind data to be entered into the program from tape.

TERMINATING THE TRAJECTORY COMPUTATIONS

The RAMS network in the St. Louis metropolitan area encompasses a 110 by 110 kilometer (69 x 69 miles) square. Extrapolating the trajectory calculations past these boundaries are based on less reliable wind data and the accuracy of the results deteriorates rapidly.

The grid boundaries are entered into the trajectory program and each time the trajectory location is recalculated its position is checked against those of the grid boundaries. The last position calculated is the one immediately preceeding the crossing of the grid periphery.

This total RAMS area is referred to as the regional trajectory network. The boundaries are the following:

NORTH: 4,340,000N UTM
EAST: 790,000E UTM
SOUTH: 4,230,000N UTM
WEST: 680,000E UTM

The scaling needed to depict the trajectory for this area in the 8 1/2" by 11" format given by Fig. 3 is fixed at 16.1KM to the inch.

Other versions of the trajectory program include metropolitan and urban scales where finer resolution can be provided. Their grid sizes are 50 by 50 KM and 20 by 20 KM respectively. The coordinates of the boundaries are movable to include any area defined by the regional grid.

A less frequent occurence is that of the trajectory remaining within the confines of the grid for the maximum of 12 hours. The trajectory can be continued from the last point calculated in a second run of the program. With this method the accompanying trajectory plots and tabular printouts will be in two parts. These outputs will be discussed in the next two sections.

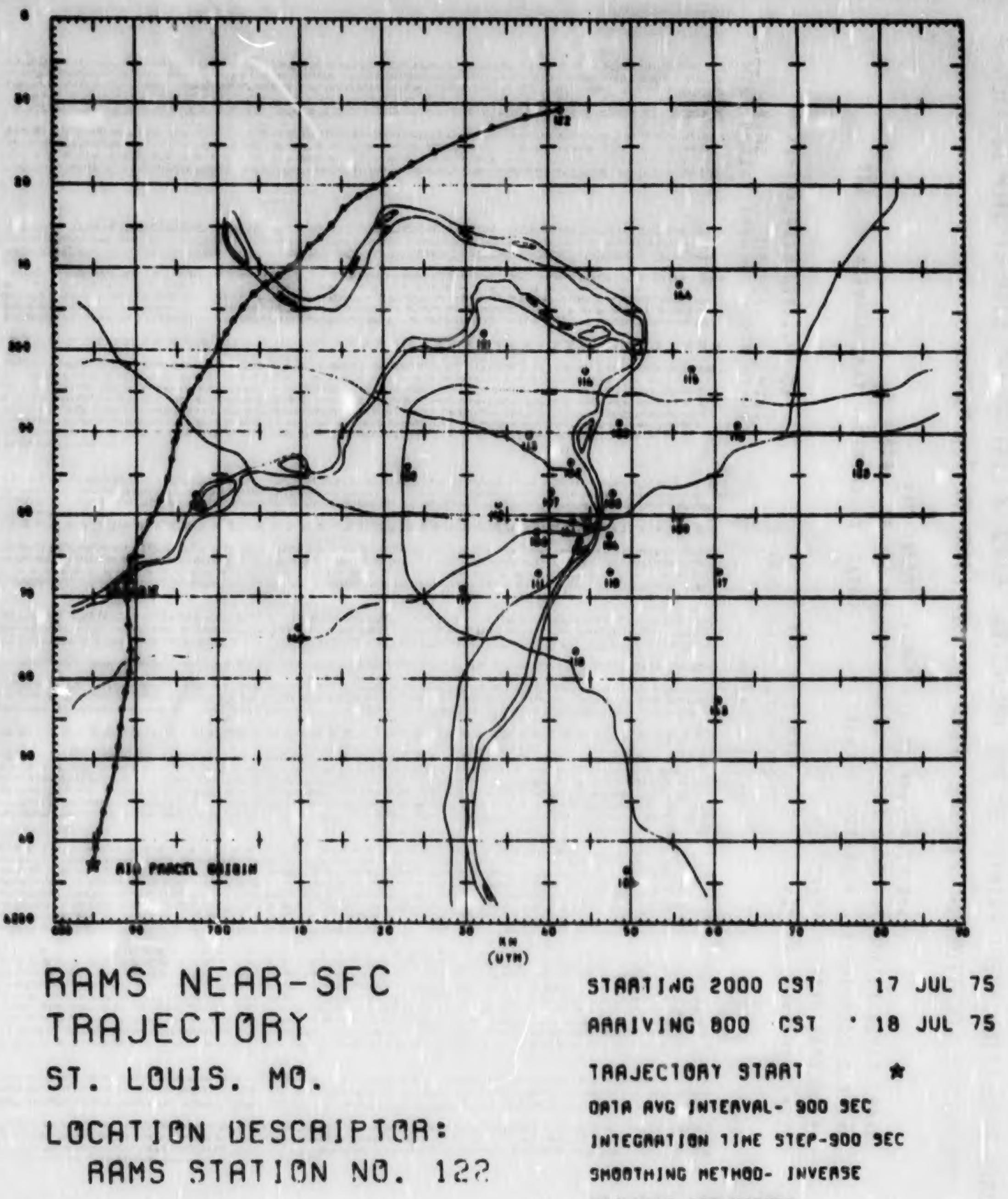
If less than twelve hours of a trajectory are needed, the reduced input of raw wind data might automatically stop the trajectory before the parcel leaves the grid boundaries. Input on cards control both the amount of data read as well as the access of the proper data on tape.

THE TABULAR SUMMARY OF RESULTS

Each subroutine module in the trajectory program is designed to be able to print the results of any calculations for cross-checking purposes. These program options will all be discussed in Section 6. At the end of each trajectory run a summary sheet is produced (Table 7) which lists all the important facts pertaining to the trajectory.

The header in Fig. 3 describes a combination of computed and inputed data. Depending on whether the trajectory is foreward or backward either the start time or end time is predefined. The other is calculated in the program. The initial coordinates, in UTM northing and easting, are those of RAMS station 122. The trajectory described in Fig. 3 took the full allotment of 12 hours, 48 15-minute steps, without leaving the regional grid.

The data in Table 7 describes the coordinate location of the calculated


0
90
80
10
300
90
80
70
60
50
40
4200
680
90
700
10
20
30
40
50
60
70
80
90
KM
(UTM)
AIR PARCEL ORIGIN
122

RAMS NEAR-SFC
TRAJECTORY
ST. LOUIS. MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 122

STARTING 2000 CST 17 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

FIGURE 3. THE FORM USED TO DISPLAY THE REGIONAL TRAJECTORY INFORMATION CALCULATED BY THE CONTRACTOR'S MODEL COMBINING THE HEADER INFORMATION AND REPRESENTATIVE TRAJECTORY PATH PRODUCED BY A CALCOMP PLOTTER WITH THE REGIONAL UTM GRID SCALED ACCORDINGLY

TABLE 7. A DATA TABULATION SHEET PRINTED BY THE TRAJECTORY PROGRAM LISTING THE STEP BY STEP DETAILS OF THE TRAJECTORY LOCATION AND AVERAGE SPEED AND DIRECTION OF THE PARCEL

```
                        RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY
      START TIME: 17 JUL 75  2000 CST      END TIME: 18 JUL 75   800 CST
      INITIAL COORDINATES: 4329223N. 741631E.   LOCATION DESCRIPTOR: RAPS STATION NO. 122
      TRAJECTORY TYPE: BACKWARD IN TIME
      STEP INTERVAL:  15 MIN            NUMBER OF STEPS: 48                       ACCUMULATED DISPLACEMENT
                                      INCREMENTAL DISPLACEMENT               PATH       AZIMUTH           SPEED
STEP   TIME          LOCATION          RADIAL      AZIMUTH      SPEED       LENGTH   (FROM ORIGIN)    (ALONG PATH)
  0    800 CST   4329223N.  741631E.       0 M      0 DEG      0 M/SEC         0 M      0 DEG        0 M/SEC
  1    745 CST   4328161N.  737364E.  4396.5 M  256.0 DEG   4.88 M/SEC    4396.5 M  256.0 DEG     4.88 M/SEC
  2    730 CST   4326879N.  733380E.  4185.5 M  252.2 DEG   4.65 M/SEC    8581.9 M  254.1 DEG     4.77 M/SEC
  3    715 CST   4325444N.  729705E.  3943.9 M  248.7 DEG   4.38 M/SEC   12525.8 M  252.4 DEG     4.64 M/SEC
  4    700 CST   4323915N.  726298E.  3644.8 M  245.1 DEG   4.05 M/SEC   16170.6 M  250.8 DEG     4.49 M/SEC
  5    645 CST   4322461N.  723632E.  3125.3 M  242.3 DEG   3.47 M/SEC   19295.9 M  249.4 DEG     4.29 M/SEC
  6    630 CST   4321063N.  721262E.  2751.2 M  239.5 DEG   3.06 M/SEC   22047.1 M  248.2 DEG     4.08 M/SEC
  7    615 CST   4319662N.  719146E.  2526.5 M  236.3 DEG   2.81 M/SEC   24573.6 M  247.0 DEG     3.90 M/SEC
  8    600 CST   4318493N.  717311E.  2187.0 M  237.7 DEG   2.43 M/SEC   26760.6 M  246.2 DEG     3.72 M/SEC
  9    545 CST   4317039N.  715459E.  2355.4 M  231.9 DEG   2.62 M/SEC   29117.0 M  245.3 DEG     3.59 M/SEC
 10    530 CST   4314959N.  714035E.  2531.3 M  214.8 DEG   2.81 M/SEC   31648.4 M  242.7 DEG     3.52 M/SEC
 11    515 CST   4313494N.  712676E.  1984.3 M  222.4 DEG   2.20 M/SEC   33632.6 M  241.5 DEG     3.40 M/SEC
 12    500 CST   4312490N.  711289E.  1718.2 M  233.8 DEG   1.91 M/SEC   35350.9 M  241.1 DEG     3.27 M/SEC
 13    445 CST   4311195N.  710191E.  1703.3 M  220.5 DEG   1.89 M/SEC   37054.1 M  240.2 DEG     3.17 M/SEC
 14    430 CST   4309942N.  709945E.  1752.8 M  224.8 DEG   1.95 M/SEC   38806.8 M  239.5 DEG     3.08 M/SEC
 15    415 CST   4309901N.  707983E.  1717.3 M  232.7 DEG   1.91 M/SEC   40524.2 M  239.2 DEG     3.00 M/SEC
 16    400 CST   4307951N.  705040E.  1792.5 M  238.0 DEG   1.99 M/SEC   42316.5 M  239.1 DEG     2.94 M/SEC
 17    345 CST   4305713N.  704533E.  1966.2 M  231.0 DEG   2.18 M/SEC   44282.8 M  238.4 DEG     2.89 M/SEC
 18    330 CST   4305095N.  703161E.  2120.4 M  220.3 DEG   2.36 M/SEC   46403.2 M  237.9 DEG     2.86 M/SEC
 19    315 CST   4303509N.  702251E.  1935.4 M  215.0 DEG   2.15 M/SEC   48339.6 M  237.0 DEG     2.83 M/SEC
 20    300 CST   4302009N.  701139E.  1757.3 M  211.3 DEG   1.95 M/SEC   50096.9 M  236.1 DEG     2.78 M/SEC
 21    245 CST   4300294N.  700208E.  1950.3 M  208.5 DEG   2.17 M/SEC   52047.2 M  235.1 DEG     2.75 M/SEC
 22    230 CST   4298369N.  699090E.  2230.3 M  210.4 DEG   2.48 M/SEC   54277.5 M  234.1 DEG     2.74 M/SEC
 23    215 CST   4296488N.  697879E.  2231.9 M  212.6 DEG   2.48 M/SEC   56509.4 M  233.2 DEG     2.73 M/SEC
 24    200 CST   4294792N.  696826E.  1996.0 M  211.8 DEG   2.22 M/SEC   58505.4 M  232.5 DEG     2.71 M/SEC
 25    145 CST   4293061N.  696055E.  1895.9 M  204.0 DEG   2.11 M/SEC   60401.2 M  231.6 DEG     2.68 M/SEC
 26    130 CST   4291014N.  695405E.  2147.6 M  197.6 DEG   2.39 M/SEC   62548.9 M  230.4 DEG     2.67 M/SEC
 27    115 CST   4288945N.  694879E.  2231.0 M  193.6 DEG   2.48 M/SEC   64779.8 M  229.2 DEG     2.67 M/SEC
 28    100 CST   4286709N.  694556E.  2169.8 M  198.6 DEG   2.41 M/SEC   66949.6 M  227.9 DEG     2.66 M/SEC
 29     45 CST   4284307N.  694036E.  2449.6 M  192.3 DEG   2.72 M/SEC   69399.1 M  226.7 DEG     2.66 M/SEC
 30     30 CST   4281756N.  693154E.  2699.5 M  199.1 DEG   3.00 M/SEC   72097.6 M  225.6 DEG     2.67 M/SEC
 31     15 CST   4279132N.  691591E.  2894.9 M  205.0 DEG   3.22 M/SEC   74992.5 M  224.8 DEG     2.69 M/SEC
 32      0 CST   4276698N.  690590E.  2779.1 M  202.9 DEG   3.09 M/SEC   77771.6 M  224.2 DEG     2.70 M/SEC
 33   2345 CST   4274560N.  689557E.  2374.5 M  205.8 DEG   2.64 M/SEC   80146.1 M  223.6 DEG     2.70 M/SEC
 34   2330 CST   4272341N.  689153E.  2255.6 M  190.3 DEG   2.51 M/SEC   82401.6 M  222.7 DEG     2.69 M/SEC
 35   2315 CST   4269798N.  689179E.  2542.9 M  179.4 DEG   2.83 M/SEC   84944.5 M  221.4 DEG     2.70 M/SEC
 36   2300 CST   4266710N.  689339E.  3091.5 M  177.1 DEG   3.44 M/SEC   88036.0 M  219.9 DEG     2.72 M/SEC
 37   2245 CST   4263664N.  689575E.  3055.9 M  175.5 DEG   3.40 M/SEC   91091.9 M  218.5 DEG     2.74 M/SEC
 38   2230 CST   4260968N.  689400E.  2696.8 M  191.8 DEG   3.00 M/SEC   93788.7 M  217.4 DEG     2.74 M/SEC
 39   2215 CST   4258511N.  688930E.  2507.9 M  191.5 DEG   2.79 M/SEC   96296.5 M  216.7 DEG     2.74 M/SEC
 40   2200 CST   4256367N.  688554E.  2188.1 M  191.5 DEG   2.43 M/SEC   98484.6 M  216.1 DEG     2.74 M/SEC
 41   2145 CST   4254186N.  688339E.  2190.9 M  195.6 DEG   2.43 M/SEC  100675.4 M  215.4 DEG     2.73 M/SEC
 42   2130 CST   4251816N.  688073E.  2386.9 M  196.4 DEG   2.65 M/SEC  103062.3 M  214.7 DEG     2.73 M/SEC
 43   2115 CST   4249270N.  687664E.  2579.0 M  199.1 DEG   2.87 M/SEC  105639.3 M  214.0 DEG     2.73 M/SEC
 44   2100 CST   4246539N.  687014E.  2788.5 M  193.3 DEG   3.10 M/SEC  108427.8 M  213.5 DEG     2.74 M/SEC
 45   2045 CST   4243790N.  686230E.  2861.7 M  195.3 DEG   3.18 M/SEC  111289.4 M  213.0 DEG     2.75 M/SEC
 46   2030 CST   4241403N.  685659E.  2459.1 M  193.1 DEG   2.73 M/SEC  113748.5 M  212.5 DEG     2.75 M/SEC
 47   2015 CST   4239422N.  685328E.  2015.3 M  190.6 DEG   2.24 M/SEC  115764.0 M  212.1 DEG     2.74 M/SEC
 48   2000 CST   4237360N.  684959E.  2094.9 M  190.1 DEG   2.33 M/SEC  117858.9 M  211.7 DEG     2.73 M/SEC
```

air parcel at each 15-minute interval. In the "incremental displacement" column the distance traveled, the speed, and the direction of travel are given between each 15-minute trajectory location. Under the "accumulated displacement" header are given the same parameters except that they are calculated from the trajectory origin.

It is evident from this particular product that substantial changes in the air parcel motion can be reconstructed during the diurnal time frame. Examples to be discussed in Chapter 8 show the effects of squall line and frontal passages and even minor circulations that produce no sensible "weather" changes.

OBJECTIVE PLOTTING OF TRAJECTORIES

It became evident that the ability to calculate accurate trajectories would quickly outstrip in both quantity and quality the ability to manually depict the results properly. A separate computer module has been developed to take the resultant coordinates of the trajectory output and objectively portray the results on a 2-dimensional plotter. When the product was refined and thoroughly tested, this program was included directly in the trajectory package as a subroutine. The Calcomp is a refined plotting tool with the ability to draw coordinate axes, plot numbers, letters, and symbols, connect points on a curve, and do many other operations. This software item has the capability of producing Fig. 3 in its entirety. However due to the time involved in drawing all the grid lines and legends, the Calcomp output was limited to the top and bottom headers, the connected triangles representing the air parcel path, and two marks identifying the location of stations 125 and 123 so that the grid, with accompanying station locations, could be later superimposed.

The type of trajectory is described in two ways. First the legend explicity indicates "backward trajectory". Secondly the beginning of the trajectory is marked in with a star and is labeled "Air parcel origin" while the other end terminates at a RAMS Receptor.

This particular case was traced backwards directly over the Labadie Power Plant. Checking against the data summary it can be determined that the air parcel arriving at station 122 at 0800 on July, 1975 interacted with the Labadie Plant at 2330 LST the evening before, traveling 8 1/2 hours. A foreward trajectory can be defined using the Labadie source and various times before and after 2330 LST to determine the steadiness of the air parcel paths containing the Labadie "plume".

It should be emphasized that, due to the iteration techniques used in the "stepping" of the trajectory, the foreward starting at the near Labadie point (4272341N and 619153E from Fig. 3) will arrive only a few tens of meters from station 122 at 0800 the next morning, duplicating the steps of the backward trajectory.

SECTION 6

CAPABILITIES AND LIMITATIONS OF THE MODEL

WIND AVERAGING TECHNIQUES

The previous section describes the current methodology to utilize 15-minute averages in the construction of meaningful air parcel velocities. The technique employed introduces a weighting that is inversely proportional to the distance between the trajectory location and the nearby stations. Several other smoothing modules have been derived and are interchangeable with the current subroutine WEIGHT described in Table 5.

The most analytical approach is that of a least squares fit. This technique is very suited to the problem of determining the wind speed and direction at a point P surrounded by N data points at varying distances. These N points are used to derive an analysis of the wind field which then can be interrogated at every point. The equation which represents the general solution of the wind analysis is a 2nd order polynormal in the form

$$V = A_0 + A_1x + A_2x^2 + A_3xy + A_4y + A_5y^2$$

where x and y are the coordinates of the observed wind stations to be inputed and the vector coefficients are derived by the method of least squares.

As an example for the u component the general equation is

$$\sum_{i=1}^{N} (-2x_i^2)\ [u(x_iy_i) - a_0 - a_1x_i - a_2x_i^2 - a_3x_iy_i - a_4y_i - a_5y_i^2] = 0$$

This represents the general solution for the u component anywhere within the influence of the N stations and requires the solution of six equations with six unknowns. This solution minimizes the sum of the residuals, or differences, between the general solution for u and at the location of N data points and the observed N values of u. An efficient matrix algorithm has been offered by Faddeeva (1963) for the solution of this least squares technique for an estimate of both the u and v component of the wind at the trajectory location.

Several drawbacks rear themselves in this approach:

1. A minimum of the six most proximate stations' data are necessary to solve these least squares equations. Even though 25 stations are interrogated, significant data outages occur regularly so that the technique is invalidated when the wind data from only 5 or less stations are available.
2. Due to the substantial increase in complexity of this technique over that of the inverse weighting, the computer costs have been multiplied by several factors.
3. Calculations of derived products such as vorticity and divergence from the fields of u and v supplied by both the inverse and least squares methods showed not enough departure to warrant the increased computer cost.
4. Forcing the fit of a 2nd degree polynomial onto the urban wind field can lead to wide discrepancies in certain areas. Inclusion of only one bad data point forces non-fit at many other points. Holding either x or y constant gives a parabolic solution which can simulate frontal zones but will fail to reproduce the more complicated regimes which accompany light wind and mesoscale convective phenomena.

There are also some distinct advantages to this least squares approach.

1. Since the method employed does not force an exact fit of the data points the method performs a smoothing over the network used. The least squares technique therefore, does not fit flagrant wind data, but minimizes the sum of all the squares of the differences between the real data and the polynomial approximation.
2. A polynimial approximation can produce maximums, minimums, ridges, and troughs between the data points based on the surrounding information of at least 6 other data points.

A third wind averaging module is available as a result of previous EQR in-house development which utilizes an exponential-inverse weighting. As with the other methodologies, this technique is completely contained in a separate weighting subroutine, interchangeable with any other.

The principle behind this smoothing is very similar to the preferred inverse weighting except that the basic wind weighting is defined by:

$$\text{WEIGHTING} = e^{\left(\frac{\text{DISTANCE}}{-14.42695}\right)}$$

where DISTANCE is the separation in meters between the trajectory location and the station to be used in the weighting. Table 8 compares the two inverse techniques so that they are comparable for distances of 0 and 10 Km.

TABLE 8. COMPARISONS BETWEEN THE SIMPLE INVERSE AND EXPONENTIAL INVERSE WEIGHTING TECHNIQUES

Distance (km)	$\frac{10}{\text{Distance (km)} + 10}$	$e^{\left(\frac{\text{Distance (km)}}{-14.42695}\right)}$
0	1.0000	1.0000
1	.9091	.9330
2	.8333	.8706
4	.7143	.7579
6	.6250	.6598
8	.5556	.5743
10	.5000	.5000
15	.4000	.3536
20	.3333	.2500
30	.2500	.1250
40	.2000	.0625
50	.1667	.0313
60	.1429	.0156
80	.1111	.0039
100	.0909	.0010

There are two disadvantages to the exponential technique:

1. There is a slight computer cost increase per calculation which, due to the reiterative nature of the trajectory calculations, adds a substantial amount to the cost of the entire trajectory.
2. In cases where the ten kilometer circle must be expanded to locate at least two data points for the smoothing, the weighting of the exponential equation drops off considerably, putting almost total emphasis on the closest point. The simpler inverse technique

reduces this emphasis to a more reasonable amount and produces more smoothing under these conditions.

Further in-house research is being continued by EQR to develop and document these and other methodologies.

OPTIONS BUILT INTO THE TRAJECTORY PROGRAM

The intent of EQR in developing a general and widely applicable trajectory program was to allow for maximum optimization of the different types of wind data available and for maximum variety of applicability of the final product.

Table 9 describes a list of variables that can be read into the trajectory program in card format to generalize its application.

TABLE 9. VARIABLES THAT CAN BE READ INTO THE TRAJECTORY PROGRAM IN COMPUTER CARD FORMAT TO GENERALIZE ITS APPLICATION

VARIABLE	DESCRIPTION
1. STIME	start time (LST) of trajectory in hours and minutes
2. ETIME	end time (LST) of trajectory in hours and minutes
3. LDATE(3)	alphanumeric description of month, year, and date of initial time of trajectory
4. JDATE(3)	alphanumeric description of month, year, and date of final time of trajectory
5. DELT	If DELT equals 900 input data is combined into 15-minute averages. If DELT is 60, input data is used as it stands and every 15th trajectory step is plotted and documented.
6. IBLOCK	describes how many 4-minute blocks of data will be read from the RAMS data tape
7. SIGN	is either +1: foreward trajectory -1: backward trajectory
8. IPASS	indicates how many 4-minute blocks of wind data will be passed over on the RAMS data tape in the first file accessed to start the trajectory at the proper time

(continued)

TABLE 9 (continued)

VARIABLE	DESCRIPTION
9. JADD	indicates whether to skip 0, 1, 2, or 3 minutes of data in the first 4-minute block to start the data read precisely on time
10. NPRINT	entered as 1 allows the program to skip the printing of all 15-minute averages calculated from the RAMS minute tape
11. MPRINT	entered as 1 allows the program to skip all prints pertaining to the intermediate trajectory calculations
12. MDP	refers to the number of wind stations used (is at most 25 for RAMS data)
13. MAX	defines the circle around the immediate trajectory location inside of which the wind averaging is accomplished (is 10000 meters in the current model)
14. IDEN(25)	defines the station numbers
15. YY(25)	defines the northing in UTM coordinates for the stations
16. XX(25)	defines the easting in UTM coordinates for the stations
17. YSTART	fixes the northing of the initial trajectory step
18. XSTART	fixes the easting of the initial trajectory step
19. IPLACE(5)	gives the alphanumeric description of the trajectory starting location
20. XEAST(2)	describes the east and west extremities of the grid boundaries
21. YNORTH(2)	describes the north and south extremities of the grid boundaries
22. FACTOR	gives the scale factor of the grid to be used (km/in)

LIMITATIONS DUE TO THE STORAGE REQUIREMENTS OF THE PROGRAM

The factor which is the most difficult to accommodate into the trajectory program is the need of inputing twelve hours of minute RAMS data for 25 stations into the trajectory calculations. There are 24 variables per station per minute on the RAMS data tape that must be processed. A simple calculation shows that 432,000 statistics must be interrogated in order to follow one air parcel for 12 hours.

The computing facilities of Washington University in St. Louis, Missouri, executes all programs on an IBM 360 with cost options as a function of the fast core storage demanded by each job. The maximum program size, including space for data allocation, program storage, and periphial software subroutines, is 500 times 210 bytes (500K) where one real variable occupies 8 bytes and one integer variable occupies 4 bytes. Even with no space allocation given to the program or software routines only 128,000 integers can be stored in active core.

Certain compromises had to be made at the program's outset to accomplish the following 2 goals:

1. Keep at least 12 hours of 15-minute wind averages in active storage so that multiple trajectories can be calculated without additional data rereads.
2. Mimimize the program size to less than 200K to reduce program cost.

The above two objecrives were met by eliminating:

1. The capability of the model to store an average of any other meteorological or air chemistry data available on the RAMS data tape. Only each minute of wind speed and direction are retained.
2. The accuracy past 5 significant figures for all inputed wind speed and direction data. All wind data is stored in integer form, multiplied by a factor of 10,000. Truncation and round-off errors will accumulate in integer form. This will be discussed further in a following subsection.
3. The individual minute wind data after 15-minute averages have been calculated. The total storage allows for the retention of all 12 hours of 15-minute averages and 120 minutes of individual minute wind data corresponding to one file of data. Certain minutes that are needed with the next file of data to perform the 15-minute averaging (up to 14 values) are also carried over.
4. The possibility of calculating more than one 12-hour trajectory

when using only unaveraged RAMS minute data and 1-minute time steps. After a maximum of two hours of calculation, a new file of wind data is read in, replacing the previous data base. The program is not designed to rewind the input RAMS data tape. Additional trajectories must be accomplished by rerunning the program.

5. The extension of a trajectory calculation past the 48 steps currently employed. For trajectories longer than 12 hours using input wind data over a several state network (e.g., 3 to 7 days to follow a large scale air pollution build-up) the program must be modified to produce one or two hour averages with a similarly proportioned time step. In this procedure the iteration steps are essential to reduce accumulated error. It is likely that the iteration criteria of 1 meter can be relaxed somewhat for the large scale trajectory calculations.

CAPABILITIES DEPENDING ON THE NATURE OF THE INPUT WIND DATA

As was alluded to in the previous section, the calculation of trajectories in various time and area frames necessitates changes in the wind averaging techniques and often changes in the data base itself.

Using the RAMS minute data supplied for the entire St. Louis area (Fig. 1) several different modes of application are possible:

1. The Regional scale trajectory, shown in the diagram of Fig. 3, extends the data capabilities of the RAMS network to the fullest. The grid boundaries are fixed at a distance past the nearest station not farther than the station to station distance of the nearest two wind measuring points. This ensures that extropolation of wind data is still representative at the boundaries.

   The Regional scale uses RAMS 15-minute averaged data by definition of the scope of the area to be traversed and the time needed to complete the trajectory. The intent of the Regional scale grid being designed as shown in Fig. 3 is that the interaction between the entire St. Louis emission inventory and the St. Louis Metropolitan area can be covered.

2. The Metropolitan scale grid is a 50 by 50 km grid set within the Regional scale. It is usually affixed at the center of the Regional

grid of Fig. 3 to cover the St. Louis city and East St. Louis emission inventory maximums. Depending on the wind direction and coverage required the grid can be positioned anywhere as long as the true North (UTM) is maintained.

At the Metropolitan scale the option for use of 1-minute trajectories exists. At this scale every 15th step is tabulated on the summary sheet and is plotted on the Calcomp depiction. No time limit is set on the trajectory length since the program will accept two hours of RAMS minute data continuously when 15-minute averaging is not being performed. The trajectory ends at the grid boundaries. When 15-minute averages are used, a 48 step limit (12 hours) is imposed, but usually the trajectory crosses the grid boundary and ends well before this option is exercised.

3. The intent of the use of the Urban scale is detailed tracking of some plume or tracer and the 20 by 20 km grid can be moved anywhere inside the Regional grid. The use of the minute data is necessitated.

   An added program option is for inclusion of additional supportive surface wind data taken to better define the low level wind flow at the time of the experiment. These supplementary data are entered in card form as though they are defining corrections. Station numbers are defined for these additional locations starting from 126, 127 . . . etc. and the wind speed and direction values are initially defined as missing (i.e., 99.999). The card read-ins will take precedence. The UTM coordinates of these supportive stations are entered with those of the RAMS network in card form.

   Since the Urban grid is usually set up entirely within the RAMS network, some of the RAMS stations can be eliminated from the calculations, reducing the calculations. The total number of stations used, including the RAMS and the supplementary networks, must be kept at 35 or less to minimize the storage class that determines the program costs.

4. The trajectory program has the capability of operating totally exclusively of the RAMS network at any scale accepting wind observations in either magnetic tape or card form. Despite the endless varieties,

the experiment design and data availability can be adapted by the model.

SOURCES OF ACCUMULATED ERROR

The discrepancy between the trajectory product and the observed results can be attributed to three main sources:

1. The unrepresentativeness of the input wind data to be applied to the specific trajectory required.
2. The unrepresentativeness of the algorithm employed to generate a trajectory.
3. The unrepresentativeness at the algorithm to select an average wind at the trajectory location.
4. The unrepresentativeness of the mathematical techniques used to simulate the various program algorithms.

Each of these four aspects of the trajectory model influences, in a cumulative fashion, the final results. The following discussion describes these four sources of error.

Wind Data

The Introduction describes numerous uses of the trajectory concept. However, the various scales of applicability must be characterized by different types of wind data.

RAMS minute data tapes, in the original UNIVAC 1110 format, contain 35 bits of information for each real number stored. Twenty-six bits of information contain the mantissa or significant figures for all the RAMS data including that of wind speed and direction. This assures that none of the original data accuracy is lost in packing the RAMS data onto tape for archiving.

As was discussed previously the MRI wind system used to determine wind speed is accurate to .06 meters per second or to 1% of the windspeed, whichever is greater. This guarantees that the error for each 15-minute time step due to wind sensor measurement limitations will be less than 60 meters. If the sensor error is biased, which is likely, then the trajectory errors will tend to accumulate in time, especially as the actual and calculated parcellocations become more separated spacially.

Operationally, wind speeds and directions observed at a given frequency can be calculated two ways:

1. Winds can be observed instantaneously at a fixed interval of time.
2. Winds can be vectorially averaged over a fixed interval of time.

The first choice has merit when fields of wind speed and direction are to be evaluated either for hand analysis or by analytical techniques such as the least square 2nd order polynomial, described at the beginning of this section. Instantaneous observations, synoptic in time, will give the maximum determination of the wind field at that instant of time as long as small turbulence effects on the wind sensors can be controlled.

The second method of wind calculation averages the wind over a period of time, "smearing" the mesoscale scale detail but also eliminating, especially in short frequency observations such as the minute RAMS data, the turbulence and roughness generated fluctuations that are not representative of the actual air parcel motions.

Higher frequency wind data is essential for the short term, minute by minute, trajectory stepping. In the Urban and Metropolitan scales, when minute RAMS data is used, individual plumes can be followed with accuracy out to 6 hours of travel.

When 15-minute time steps are used for longer trajectories, the inaccuracy increases since the estimate of the wind at the trajectory location is derived from the nearest 15-minute averaged wind data. The only meteorological difference in winds among the several stations to be used in the creation of a trajectory point wind that should be incorporated into the average is the one produced by some phenomenon moving through the network of stations. Differences caused by turbulence at a station or by local topographical influences should not be extrapolated out to other points.

Aside from averaged wind data being unrepresentative in time scale, the largest source of discrepancy is caused by the difference between the level at which the wind is measured and the level at which the air parcel is being carried. So called "surface" winds are valid only at the heights of their observations. Due to the physics behind the Ekmann Spiral concept concerning the change of winds in the near-surface boundary layer the following two concepts are usually observed;

1. The wind directions turn clockwise with increasing height.
2. The wind speed increases exponentially with increasing height.

To quantify these relationships the ambient vertical temperature profile and the surface roughness characteristics must be specified.

Due to the omnipresence of wind speed and directional shears, stack plumes and tracer clouds released near the surface tend to become smeared both vertically and horizontally. Occasionally bifurcation, plume-spitting, or excessive looping that produces "puffs" at a fixed receptor will occur. Substantial research must be undertaken to determine the proper adjustments to be made on surface wind observations to best simulate the air parcel motion.

For tracking constant level balloons or other airborn quanta that undergo no dispersion the problem is simplified but still remains: How can surface winds be modified to become representative at another level? One approach to the solution is to provide at least one vertical profile of winds within the network that operates on the same frequency as the surface wind network.

The accumulated error involved can be of great magnitude if the height of the parcel to be followed and the height of the defining winds are several hundred meters or more apart. It is not uncommon that 10 meter level winds and 100 meter to be at variance by 30 degrees and by 5 m/sec in speed. The entire trajectory, if left uncorrected, would also reflect these errors.

The current trajectory model has been used for only low level air parcel trajectories and contains a basic adjustment for the discrepancy in heights of the observed wind data. The complicating factors of surface roughness, which are known to have widely varying effects on the observed surface wind data, must be studied at each station location.

Trajectory Algorithm

Section 5 describes the analytical approach used to follow an air parcel through the RAMS network. The iteration assures that less than one meter disparities can occur at each trajectory step between the theoretical algorithm and its computed application.

Figure 4 describes both the path taken by the actual parcel from P_1 to

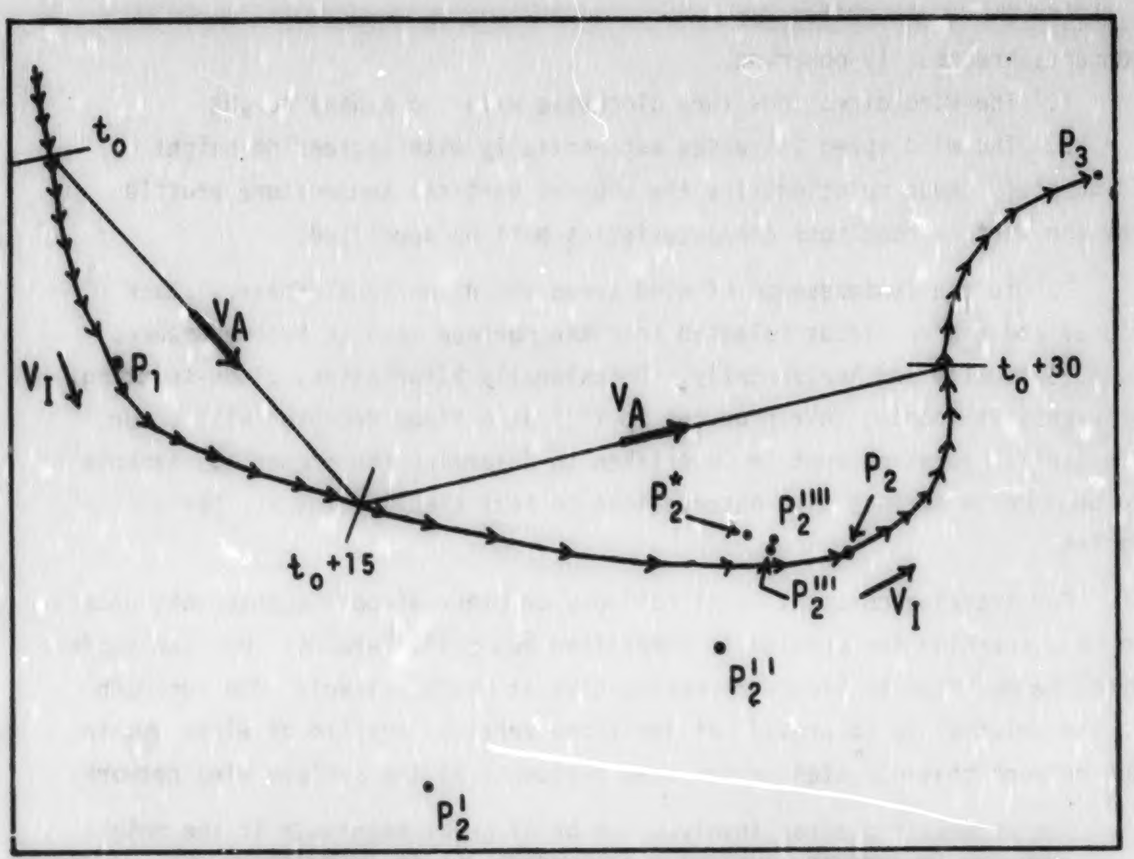


FIGURE 4. THE DESCRIPTION OF THE TRAJECTORY ALGORITHM COMPARED TO THE REAL TRAJECTORY.

P_4 and the iterated approximations of the end point. The connected arrowheads simulate the succession of instantaneous increments that constitute the continuous movement of an air parcel through the points P_1 and P_2. The points P_1 and P_2 lie exactly 15 minutes apart.

The first assumption of the algorithm used in the model states that the actual trace of the air parcel can be calculated in one step from P_1 to P_2 using the average of the winds at P_1 and P_2. These winds $\vec{V}_I$ and $\vec{V}_A$ represent the instantaneous value and the vector average of the wind at some time interval centered about P_1 or P_2. In the previous discussion about wind representativeness it was noted that instantaneous winds monitored by the RAMS network likely include turbulent effects and should be replaced by 15-minute averages.

The basic assumption of the model's trajectory algorithm states that path P_1 to P_2 can be estimated by a parcel moving from P_1 for 15 minutes at a speed and direction equal to the average of the 15 minute averaged winds centered about P_1 and P_2. This is only an approximation by definition and point P_2^*, at some discrete distance from P_2, would be the estimated end point of this trajectory step.

The accuracy of the algorithm up to this step depends on the nature of the wind along the air parcel path, especially in the 7 1/2 minutes before P_1 is reached and the 7 1/2 minutes after P_2 is passed. Any large wind change at these times, such as the marked slowing of the wind in Fig. 4, makes the average winds at V_1 and V_2 unrepresentative and will put P_2^* several hundred meters away from the real P_2. Steady winds will introduce little error and P_2 and P_2^* will be almost coincident.

It must be noted that at the next step from P_2 to P_3 the average calculated parcel speed will be too high because it now includes the 7 1/2 minutes of higher speed before the time represented by P_2. Therefore P_3, the true air parcel location, and P_3'''', the model's final approximation of the actual trajectory location, will be quite close. If the wind speed and direction becomes constant with time the estimated and actual trajectory locations should be coinsident. If the trajectory is terminated at a step when the wind field is changing, the last estimate will be in error as much as several hundred meters.

The second portion of the algorithm deals with the calculation of the wind at P_2, the location of which is undefined since only the initial location of P_1 is given. The first step calculates the point P_2' which is the end point of a 15-minute trajectory step from P_1 at a direction and speed equal to the wind speed at P_1. The air parcel speed used is approximated by a 15-minute average centered on P_1. Once the location of P_2' is determined, the interpolated wind at P_2' is calculated from the RAMS network and is averaged with V_A at P_1. A new 15-minute trajectory step is derived from P_1 to P_2''. New winds at the final step location and new 15-minute trajectory steps are iterated until two successive end points are within a small distance of each other. In Fig. 4.4 the final approximation is at P_2''''.

In each of the Regional, Metropolitan, and Urban scale applications the criteria for the termination at this iterative process is

$$P_2'''' - P_2''' \quad 1 \text{ meter}$$

The location of P_2'''' and P_2^* will be in close proximity but are not within 1 meter apart since P_2^* is defined using the wind at P_2 in the average which can never be determined explicitly except by experimental observation of either a balloon or tracer.

In practice, to enable P_2 and P_2^* to be within 1 meter apart, the vector averaged winds used would have to be accurate to .001 m/sec. However, it seems reasonable to expect errors of ± .1 to ± 1 meter/sec at each trajectory step due to the inexactness of the above wind smoothing algorithm. These speed and directional inaccuracies introduced for a curving trajectory will accumulate since a bias will occur in the algorithm. For a straight air parcel path the accumulated errors due to the algorithm approximation will be small and random. However, the farther the calculated trajectory falls from the true air parcel path the more the interpolated winds will deviate from those winds carrying the air parcel causing the rate of separation from the same path to increase.

The Wind Smoothing Algorithm

The simple and exponential inverse weighting algorithms using the ten kilometer circle still incorporate the possibility of one of the stations to be used in the average being influenced by a wind discrepancy, real or otherwise, even though there are no effects at the trajectory location. The least squares technique and the hand analysis method supposedly reproduce the wind field including the exact location of real wind perturbations. It is at these perturbations, where the wind changes drastically or near stations whose winds are out of line with the others, where trajectory errors begin to diverge, the errors usually continue to multiply.

The least squares method reduces the emphasis of a bad or unrepresentative data point but cannot eliminate it. Hand analysis of the wind field for determination of the air parcel speeds at each 15-minute interval produces the wind field with least large errors but all estimations of wind speed and direction are inexact by at least 10° and 1 meter per second.

The errors introduced by any of the wind smoothing algorithms are greater than those of the trajectory algorithm discussed in the previous section. Since the simple inverse depends on "clean" data in its averaging routine, it is suggested that subjective evaluation of all 1-meter or 15-minute averages, depending on the scale of the air parcel studies, be undertaken so that the trajectory model errors can be minimized.

It is thought that the errors due to the unrepresentativeness of the trajectory and averaging algorithms are far less than those introduced in the earlier discussion which describes the differences between the averaged surface RAMS wind data and the winds at the level of the air parcel movement.

Truncation and Round-off Errors

All wind data that is read from the RAMS minute tape to the trajectory program are stored in integer format truncating all decimal content below whole number values. This is done since integer space in the program is half the size of real variable space and allows for twice the number of variables to be held in active program storage.

In order to save significant digital content, each wind speed and direction value on tape is multiplied by 10000 before the integer storage takes place. For example a wind speed of 2.631864237... is converted to 26318.64237... and is then stored as 26318. Since the accuracy of the wind speed sensor is only $\geq$.06 m/sec, the above technique causes no loss of significant value.

All mathematical computations within the trajectory program are performed in real mode so that no losses of significant figures occur in any trajectory step. Even for an entire 12 hour trajectory the accumulated effects of truncation and round-off errors will fall well below the threshold of the accuracy of the wind values themselves.

SECTION 7

VALIDATION AND TESTING OF THE MODEL

COMPARISON TO HAND ANALYSIS

The history of EQR's Trajectory Program has consisted of several years of development and testing. The first goal was to automate the production of trajectory calculations. The second goal was to optimize the trajectory algorithm.

Hand analysis at 15-minute intervals of synoptic St. Louis urban wind data provided the earliest estimates of low level air parcel trajectories. Streamlines and isotachs were drawn for each map time from which the direction and speed at any location could be estimated. Trajectories were accomplished in a subjective fashion a step at a time.

The first comparisons between the hand analysis and an objective computerized technique were qualitative in nature and determined only that correct analytical direction was being maintained in the model. Later tests showed that several deficiencies existed in the hand-drawn trajectory product.

1. Enormous time expenditures were required to hand analyze each field of urban wind data at 15-minute intervals.
2. Hand generated analyses of wind speed and direction are only approximate to within 10° and ± 1 meter per second and the intra-station smoothing technique is not consistent.
3. Trajectory stepping was accomplished by overlaying analyses at 15-minute intervals from which the air parcel movement had to be estimated during the intervening time.

The main advantage of the subjective hand analysis technique is that the wind field can be manipulated to account for unrepresentative data, mesoscale wind discontinuities, and time continuity. The same effects could be introduced into the computerized schemes by correcting missing or unrepresentative data using card inputs and by introducing ficticious stations in data deficient areas whose wind values are estimated on the basis of subjective analysis. So far only the former has been employed.

COMPARING SMOOTHING TECHNIQUES

Various wind averaging techniques have been discussed previously. The four methods employed by EQR in its development of the low level trajectory model are the following:

1. Hand Analysis
2. Least Squares
3. Exponential Inverse
4. Simple Inverse

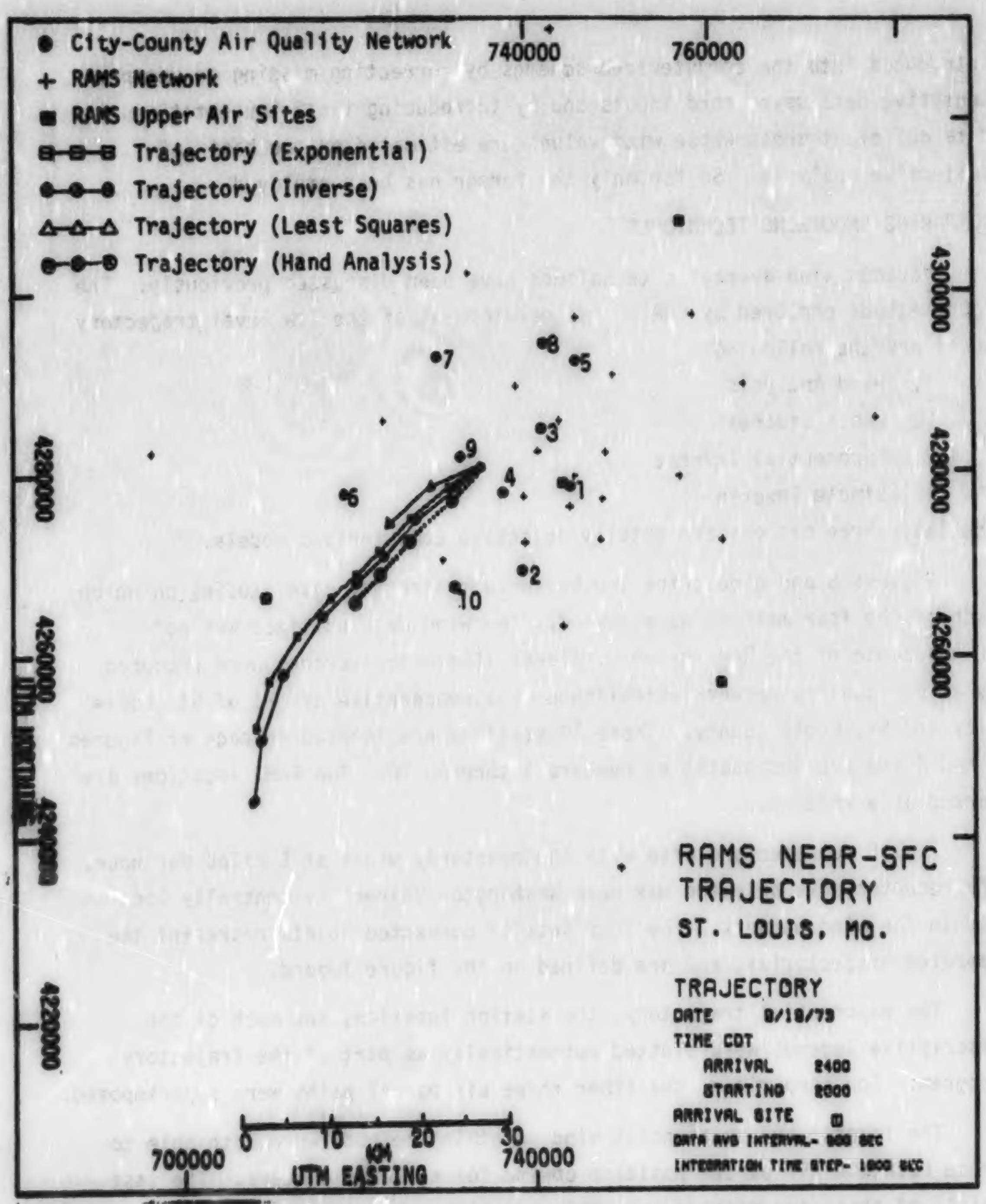
The last three methods are totally objective computerized models.

Figures 5 and 6 describe two backward trajectory case studies on which each of the four methods were tested. The wind data utilized was not of the scope of the RAMS network. These 15-minute averages were produced by an air quality network established by a cooperative effort of St. Louis City and St. Louis County. These 10 stations are located in each of Figures 5 and 6 and are designated as numbers 1 through 10. The RAMS locations are marked as a reference.

Fig. 5 represents a case with southwesterly winds at 5 miles per hour. The receptor site selected was near Washington University centrally located within the wind network. The four sets of connected points represent the computed trajectories, and are defined on the figure legend.

The exponential trajectory, the station location, and much of the descriptive legends were plotted automatically as part of the trajectory program. For comparison, the other three air parcel paths were superimposed.

The inverse and exponential wind smoothing methods were both able to trace back the air parcel position upwind for at least 4 hours. The last points of these two methods are the two estimates of the trajectory location at 2000 (LST), a discrepancy of about 10 kilometers. However, at this point, both methods are dealing with extrapolated wind data well outside of the network, precisely where the two techniques differ most. Once inside the



City-County Air Quality Network
RAMS Network
RAMS Upper Air Sites
Trajectory (Exponential)
Trajectory (Inverse)
Trajectory (Least Squares)
Trajectory (Hand Analysis)
740000
760000
4300000
4280000
4260000
4240000
4220000
UTM NORTHING
700000
740000
UTM EASTING
0
10
20
30
KM
1
2
3
4
5
6
7
8
9
10
RAMS NEAR-SFC
TRAJECTORY
ST. LOUIS, MO.
TRAJECTORY
DATE 9/19/73
TIME CDT
ARRIVAL 2400
STARTING 2000
ARRIVAL SITE
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP- 1800 SEC

FIGURE 6. A BACKWARD TRAJECTORY CASE STUDY DERIVED EMPLOYING EACH OF FOUR TECHNIQUES FOR SEPTEMBER 19, 1973, ARRIVAL TIME 2400 LST

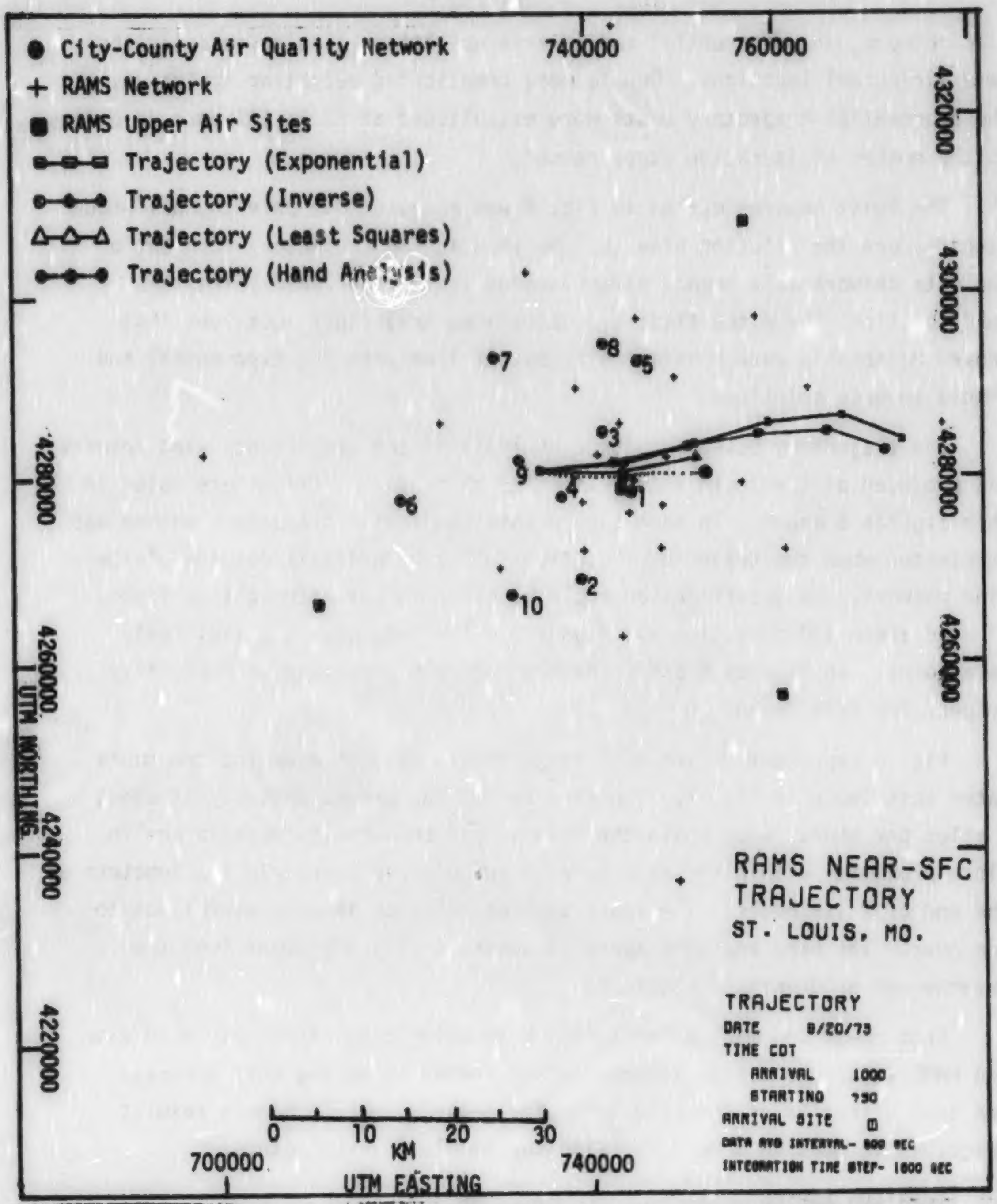


FIGURE 6. A BACKWARD TRAJECTORY CASE STUDY DERIVED EMPLOYING EACH OF FOUR TECHNIQUES FOR SEPTEMBER 20, 1973, ARRIVAL TIME 1000 LST

wind network, the exponential and inverse weightings give essentially the same air parcel locations. Due to more complicated weighting analytics, the exponential trajectory costs were established at 5% to 10% more depending on the number of iteration steps needed.

The least squares method in Fig. 5 was computed for only two half-hour steps before the solution blew up. As soon as the trajectory runs out of the data network this method always seemed to diverge rapidly from the real solution. Even the first two calculated trajectory locations that looked reasonable were substantially out of line with the exponential and simple inverse solutions.

The trajectory based on a hand analysis of the City-County wind network was produced at 15-minute intervals. The half-hour positions are noted in both figures 5 and 6. In each figure this subjective trajectory method was terminated when the trajectory location fell substantially outside of the wind network. No justification could be given to the extrapolated fields of wind speed and direction more than 15 kilometers past the last real data point. In Figures 5 and 6 the trajectory's direction is especially suspect for this technique.

Fig. 6 represents a set of 4 trajectories with an endpoint ten hours later than those in Fig. 5. The wind regime has become easterly at about 7 miles per hour. Once again the inverse and exponential methods are in close proximity within the wind network and diverge by nearly 3 kilometers at the end of 2 1/2 hours. The least squares solution is only useful out to one hour. The hand analysis again is substantially different from the inverse and exponential solutions.

From these and many other tests, both using the City-County wind data and RAMS data, the simple inverse method seemed to be the most accurate and cost effective of the wind averaging methods. All projects results described in Section 8 were run with the simple inverse method.

THE ITERATION SCHEME

The iteration process as described in Section 6 was the last major addition to the trajectory module. Several months of refining the algorithm were spent. All testing was done using the 25 station RAMS network with minute data as input in punched card format as transcribed from hard copy format. All tests were done previous to the Contractor's assigned task to adapt its inhouse Trajectory Model to RAMS magnetic tape input. The technical aspects of this portion of the project task is described in Section 5.

Due to the cumbersome task of reducing hard copy printouts to punch card format, just the one case shown in Fig. 7 was tested extensively. It was selected since both the wind speeds and directions change dramatically during the trajectory.

The station locations and their numeric coding are plotted automatically by the program. The UTM grid and highway and river depiction are superimposed. The trajectory plot and the headers were omitted during the program running and were added manually.

The 6-hour trajectory that is plotted is the final version of the recycled model consisting of 23 15-minute steps. The endpoint of the trajectory is again near Washington University at RAMS station 112. The wind regime describes the west to east passage of a high pressure ridgeline over the St. Louis area in which northwest winds become light and then increase out of the south.

The point labeled "non-cycled", immediately to the west of the end of the backward trajectory, is the source of the air parcel movement for the same time interval using no iteration in the trajectory calculation. The disparity between the two points is 3.69 kilometers, or approximately 160 meters a time step.

The iterated trajectory was retraced using the western most point as the beginning of a foreward trajectory. The difference between the end point of the foreward trajectory at 1900 LST, coinciding with the beginning of the backward trajectory, was 8 meters. This error can be attributed to round-off errors in the calculations.

USING 1-MINUTE OR 15-MINUTE WIND AVERAGES

As is described in Section 6 the EQR in-house trajectory model can be operated using the 1-minute or 15-minute averages derived from the RAMS 1-minute data tapes. This versatility is programmed into the model so that

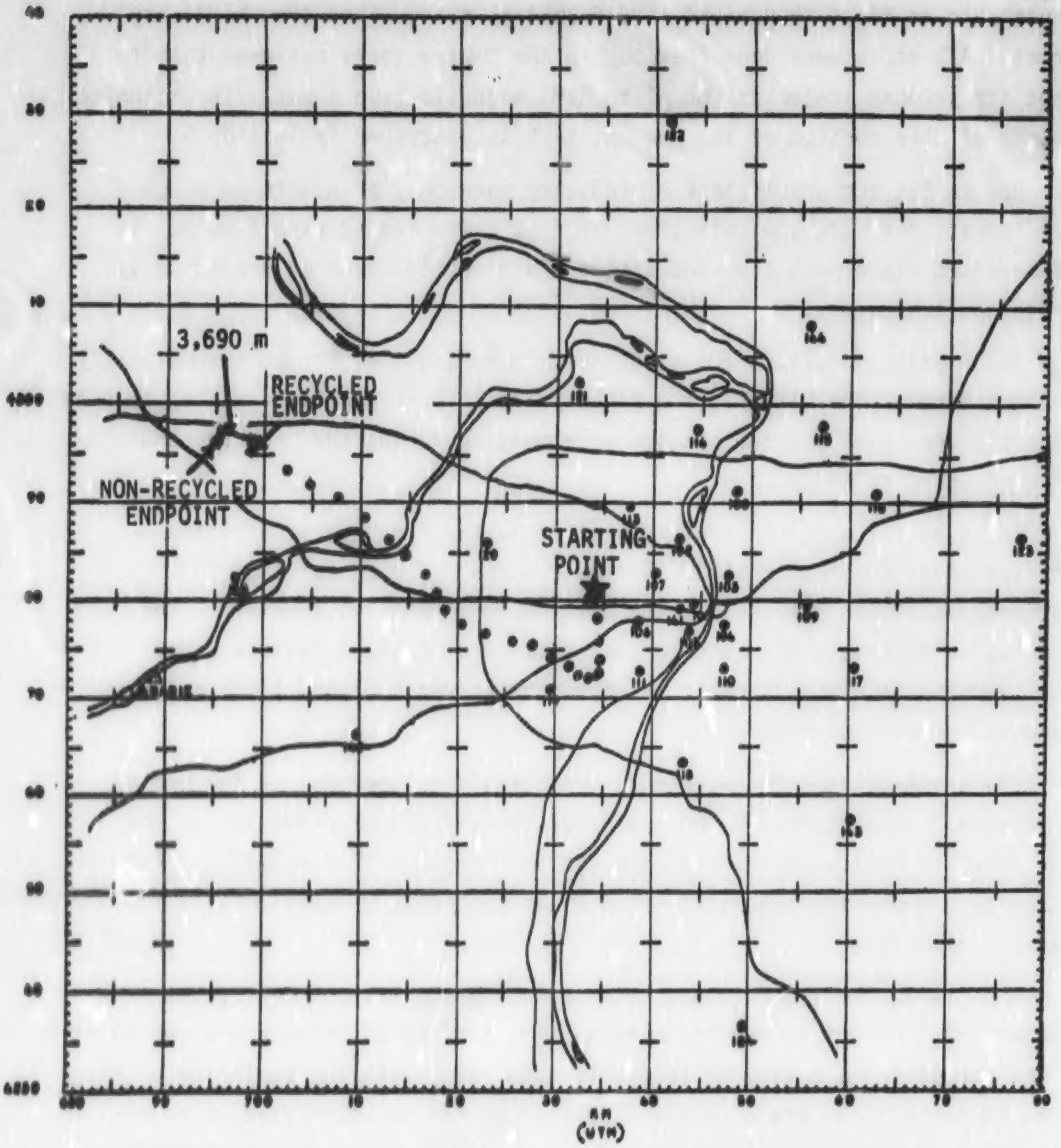

3,690 m
RECYCLED ENDPOINT
NON-RECYCLED ENDPOINT
STARTING POINT
40
30
20
10
4000
90
80
70
60
50
40
680
90
700
10
20
30
40
50
60
70
80
KM
(UTM)

FIGURE 7. A BACKWARD TRAJECTORY CASE STUDY IN WHICH RECYCLING OF THE TRAJECTORY STEPPING IS INCLUDED. THE CASE IS FOR FEBRUARY 19, 1975, AND USED AS INPUT RAMS 1-MINUTE AVERAGES IN COMPUTER COMPATIBLE TAPE FORM

meaningful trajectories can be derived depending on the scale of the problem under study.

In order to specify which program option should be used, similar trajectories were calculated using the same minute data input, one set left as 1-minute data and the other accumulated into 15-minute averages.

Several results were concluded from five separate case studies.

1. Inter-trajectory comparisons at 15-minute intervals showed that differences, in one 15-minute step up to 300 meters were generated even though recycling was used for both the 1-minute and 15-minute data sets.
2. The cost to produce a comparable trajectory with 1-minute time steps plotted at 15-minute intervals is a factor of 8 higher.
3. The 1-minute data properly simulated sub 15-minute wind oscillations and sharp wind discontinutes whereas the 15-minute vectorially averaged winds filter out high frequency wind responses.

From a study of an intermediate printout that accompanies the production of 15-minute wind averages, it was discovered that all of the 25 RAMS sites has some portion of 1-minute data that had been declared invalid or missing. The number of good data points, up to 15, used in the creation of each 15-minute averages was printed out. It showed that at least 19% of the wind data would have to be subjectively interpolated and entered in card form in order for the 1-minute data sets to be complete.

For the 15-minute averages, on the other hand, only 3 stations at the most, in any of the five cases studied, were missing all the 1-minute data for an entire 15-minute period. On the average for the 5 trajectory cases, each running out to six hours, only 6% of the 15-minute averages were missing or invalid. The reason for this is that, even if 14 out of 15 minutes of wind data are missing, the average is set equal to the lone value in the period. This approach was preferred for two reasons:

1. Any missing data, either in 1-minute or 15-minute form, invalidates the use of that station in the determination of an average wind at the trajectory location.
2. If the existence of all 15-minute values would be a requirement for

the computations of a 15-minute average then 45% of the 15-minute averages would have to be declared missing. At least 1 or 2 minutes of data were either missing or invalid in many cases.

3. It was thought that using a portion of observed data produced a far better estimate of the 15-minute average than to expend the time to subjectively or analytically determine it.

The result of this technique is that a 15-minute average computed with any missing data is not a true average and it is likely not to represent the conditions existing at that station centered about the 15-minute interval from which the data was selected.

The comparison of the 1-minute and 15-minute trajectories showed that without correcting for the many individual missing and invalid data, that

1. the 15-minute trajectories were more accurate and smoother curves in which all the data surrounding the air parcel location were available.
2. the 1-minute trajectories moved irregularly and were determined to be less accurate since data near the air parcel location, to be used in the calculation of the average trajectory motion, were only randomly available.

One of the case studies was reduced to the Urban scale so that only six RAMS stations were locally important in the air parcel movement through the system. Minute averages for the six stations were time and area interpolated so that all missing and invalid data were regenerated for a two hour period. The resulting trajectory, plotted in a minute by minute form, contained none of the irregular characteristics of the earlier ones and was deemed an accurate product. Further research and development with the Urban scale trajectory is being conducted by EQR currently.

COMPARISON TO TRACER STUDY

One of the most conclusive methods to validate an air parcel trajectory is through the release of tracer material that can be identified downwind. A dense enough network of samplers can document the centerline of the trajectory as well as the vertical and horizontal dispersive characteristics of the air stream.

Five Regional scale tracer studies were conducted in the St. Louis area coincident with the RAMS network by the California Institute of Technology, Pasadena, between August 8 and 15, 1975 (Lamb, et. al., 1975). The primary tracer used was SF_6 although in some of the releases a quantity of CBr F_3 was inputed into the test trajectory.

More than 3000 air samples were analyzed, most of these from 50 downwind automobile traverses. Additional point samples were obtained from air-borne measurements. Almost 1000 hourly averaged samples were taken from 20 fixed site locations, mostly at RAMS sites, distributed throughout the St. Louis area.

The goal of the research was not just to determine the air parcel path but to establish crosswind standard deviations at varying distances downwind to aid in Gaussian plume modeling.

In conjunction with a request from Dr. Frederick Shair, principal investigator of the tracer research, EQR supplied four foreward trajectories, each representing the tracer release point. Information concerning the releases are described in Table 10.

TABLE 10. TRACER RELEASE STATISTICS RELATING TO THE EQR FOREWARD TRAJECTORIES

Traj. No.	Date	Time (CDT)	Location	UTM Coordinates	Height of Release
1	8/8/75	1100	RAMS 111	4272479N 738812E	100'
2	8/11/75	1100	KETC-TV-tower	4263440N 728295E	1000'
3	8/12/75	2100	Webster College	4274510N 731225E	100'
4	8/15/75	1100	RAMS 111	4272479N 738812E	100'

Documentation concerning the tracer path is given in Figures 8 and 9 reproduced from a preliminary data publication referenced above. This brief project summary was a synopsis of a report presented at the RAMS meeting for the principal investigators involved in the Summer 1976 RAPS field exercise.

Fig. 8 portrays three distance cross-sections showing the concentrations of SF_6 as measured from the automobile point samples. Each profile is a result of a single automobile pass as described in the legend of Fig. 8. The time of the SF_6 sampling is approximately 1400 CDT in all cases.

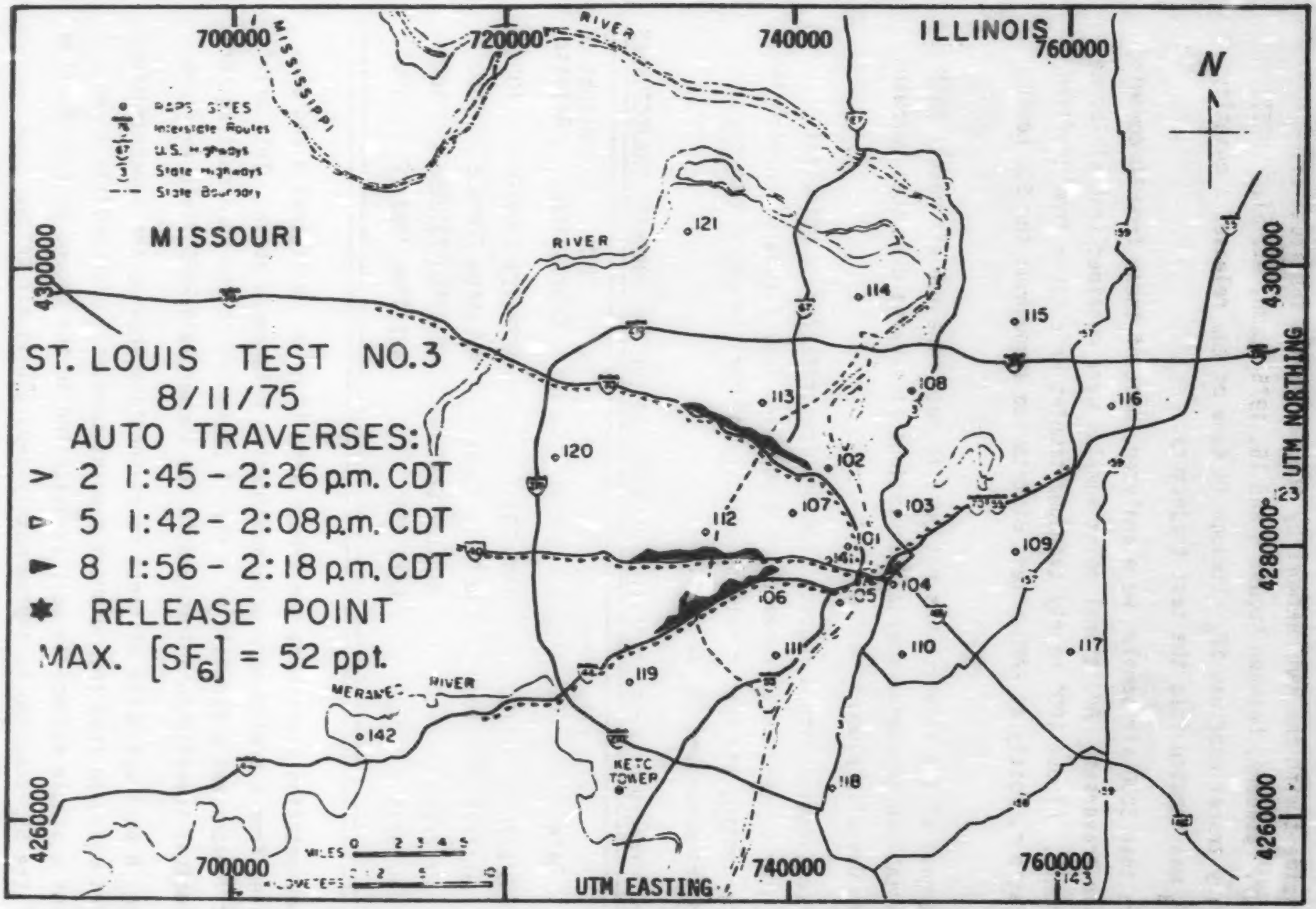

ST. LOUIS TEST NO.3
8/11/75
AUTO TRAVERSES:
> 2 1:45 - 2:26 p.m. CDT
▹ 5 1:42 - 2:08 p.m. CDT
► 8 1:56 - 2:18 p.m. CDT
✱ RELEASE POINT
MAX. [SF6] = 52 ppt.
RAPS SITES
Interstate Routes
U.S. Highways
State Highways
State Boundary
MISSOURI
ILLINOIS
MISSISSIPPI
RIVER
MERAMEC RIVER
KETC TOWER
N
UTM EASTING
UTM NORTHING
700000
720000
740000
760000
4300000
4280000
4260000
MILES 0 2 3 4 5
KILOMETERS 0 1 2 5 10
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
123
142
143

FIGURE 8. HEIGHT-TIME CROSS-SECTIONS OF SF_6 CONCENTRATIONS MONITORED DURING CONTINUOUS TRAVERSES AUG 11, 1975

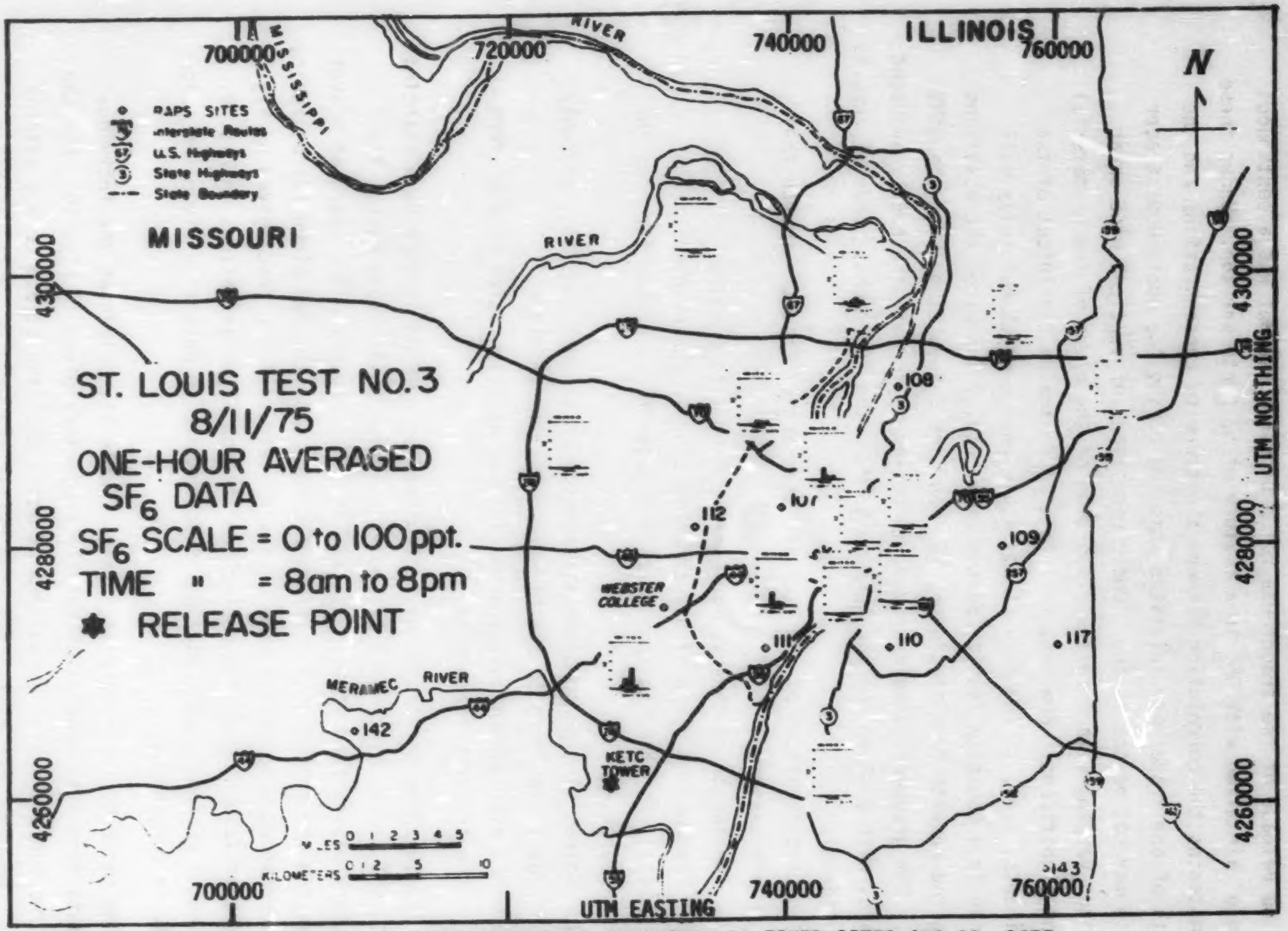

ST. LOUIS TEST NO. 3
8/11/75
ONE-HOUR AVERAGED
SF6 DATA
SF6 SCALE = 0 to 100 ppt.
TIME " = 8am to 8pm
✱ RELEASE POINT
RAPS SITES
Interstate Routes
U.S. Highways
State Highways
State Boundary
MISSOURI
ILLINOIS
MISSISSIPPI
RIVER
RIVER
MERAMEC RIVER
WEBSTER COLLEGE
KETC TOWER
108
107
109
110
111
112
117
142
143
MILES 0 1 2 3 4 5
KILOMETERS 0 1 2 5 10
700000
720000
740000
760000
UTM EASTING
4260000
4280000
4300000
UTM NORTHING
N

FIGURE 9. ONE-HOUR AVERAGED SF_6 CONCENTRATIONS MONITORED AT FIXED SITES AUG 11, 1975

The release of the tracer was not a single pulse but was a continuous stream of air mixed with SF_6 in a mixture of 52 parts per ton. Under these circumstances the correlation between the downwind concentrations and the results of one trajectory initiated sometime during the continuous tracer release may not be one to one. Under conditions of vertical wind shear and winds varying with time the dispersion of the plume of tracer material will be significant. However, this fact approximates the intent of the experiments, i.e., to induce a steady state source which hopefully will disperse in a Gaussian fashion downstream. Fig. 9 indicates the positions of and the results from stationary SF_6 monitors set up at many of the RAMS sites. The graphical displays show, in box-graph format, the hourly averaged SF_6 data, with 8 AM on the far left to 8 PM on the far right. Several results seem evident:

1. Concentrations of SF_6 decrease the farther from the source they are measured.
2. The length of observed SF_6 varies from 4 to 6 hours.
3. The maximum value of SF_6 concentration is observed earlier at stations close to the source and later for stations far from the source.
4. Spikes of high concentrations occur at several stations, probably due to shifting of the SF_6 plume over these sites.
5. The average trajectory seems to have an orientation of 210° from the tracer release site.

Fig. 10 shows the trajectory calculated using RAMS surface data starting at 1000 CST (1100 CDT). Each triangle indicates a 15-minute mark. The trajectory passes near station 114 at 1345 CDT, roughly 2 3/4 hours of travel to traverse the entire city. This trajectory was selected since its beginning time corresponded to medium time of tracer release. The track given by Fig. 10 compares favorably to the centerline through SF_6 observations in Fig. 9. The time of passage at any station is impossible to determine since the tracer release is continuous.

The table of trajectory statistics, Table 11, describes the individual 15-minute time step statistics for the trajectory given in Fig. 10. For the first two hours the wind is uniform at about 213° and at 3.5 to 4.0 meters/second. However, two subsequent wind shifts and wind speed fluctuations

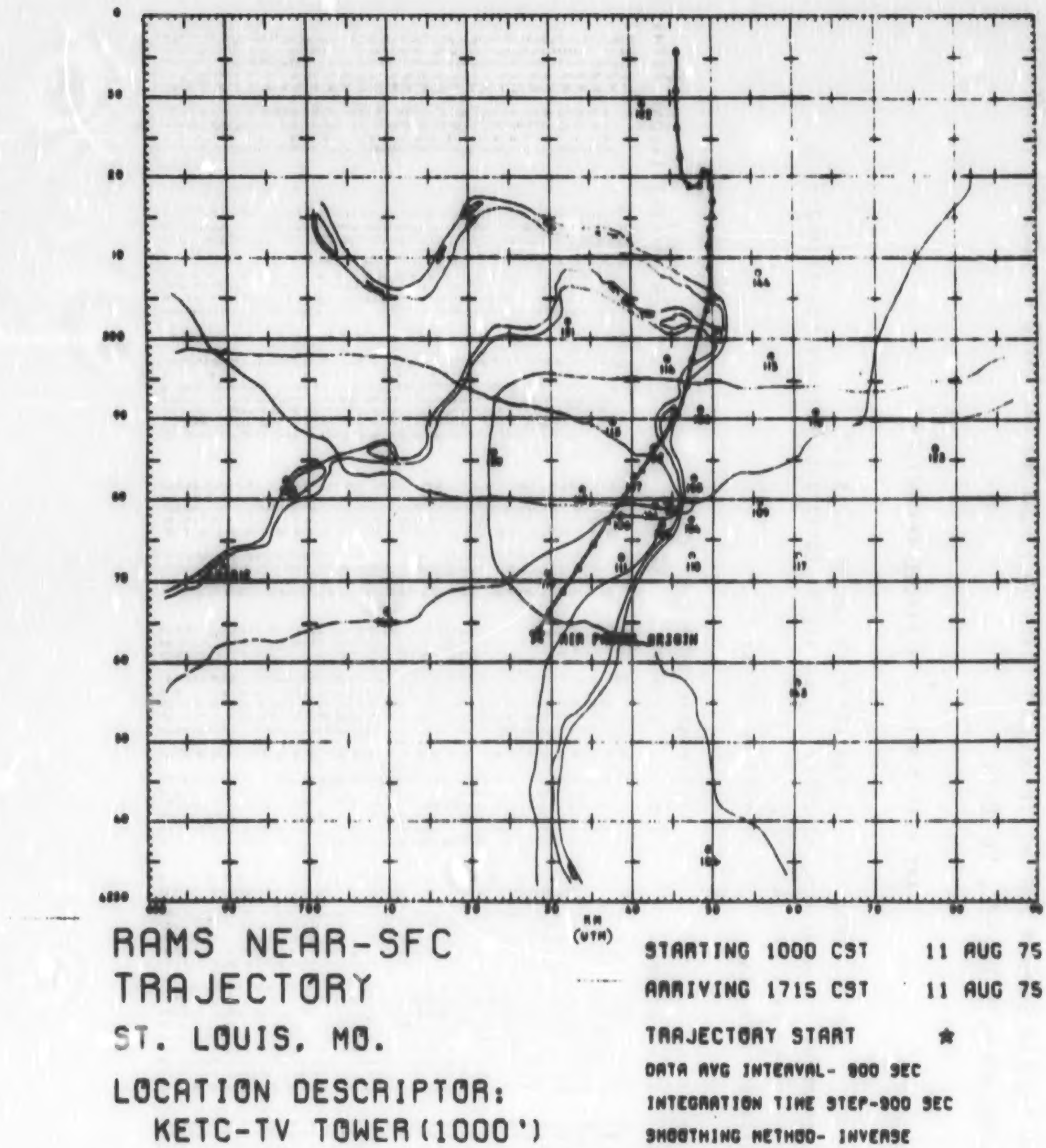

30
20
10
300
90
80
70
60
50
40
700
10
20
30
40
50
60
70
80
90
KM
(UTM)
AIR PARCEL ORIGIN
RAMS NEAR-SFC
TRAJECTORY
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
KETC-TV TOWER (1000')
STARTING 1000 CST 11 AUG 75
ARRIVING 1715 CST 11 AUG 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
FOREWARD TRAJECTORY

FIGURE 10. THE FOREWARD TRAJECTORY CALCULATED USING RAMS 1-MINUTE SURFACE DATA STARTING AT 1000 CST (1100 CDT) SIMULTANEOUS WITH THE RELEASE OF TRACER MATERIAL ORIGINATING AT THE KETC-TV TOWER

TABLE 11. THE TABULAR SUMMARY FOR THE TRAJECTORY GIVEN IN FIGURE 10 INITIATED AT 1000 CST (1100 CST) COINCIDED WITH THE KETC-TV TOWER

```
                        RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

START TIME: 11 AUG 75  1000 CST      END TIME: 11 AUG 75  1715 CST
INITIAL COORDINATES: 4263440N. 729295E.      LOCATION DESCRIPTOR: KETC-TV TOWER(1000')
TRAJECTORY TYPE: BACKWARD IN TIME
STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 29

                                                                            ACCUMULATED DISPLACEMENT
                                         INCREMENTAL DISPLACEMENT       PATH        AZIMUTH          SPEED
STEP  TIME          LOCATION          RADIAL    AZIMUTH      SPEED       LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0   1000 CST  4263440N.  729295E.       0 M       0 DEG     0 M/SEC        0 M       0 DEG        0 M/SEC
  1   1015 CST  4266208N.  729796E.  3149.8 M   208.5 DEG  3.50 M/SEC   3149.8 M   208.5 DEG     3.50 M/SEC
  2   1030 CST  4268725N.  731522E.  3052.0 M   214.4 DEG  3.39 M/SEC   6201.7 M   211.4 DEG     3.45 M/SEC
  3   1045 CST  4271536N.  733459E.  3413.3 M   214.6 DEG  3.79 M/SEC   9615.0 M   212.5 DEG     3.56 M/SEC
  4   1100 CST  4274393N.  735347E.  3424.4 M   213.5 DEG  3.80 M/SEC  13039.4 M   212.8 DEG     3.62 M/SEC
  5   1115 CST  4277231N.  737067E.  3318.4 M   211.2 DEG  3.69 M/SEC  16357.9 M   212.5 DEG     3.64 M/SEC
  6   1130 CST  4280256N.  739129E.  3660.7 M   214.3 DEG  4.07 M/SEC  20018.6 M   212.8 DEG     3.71 M/SEC
  7   1145 CST  4283597N.  741324E.  3999.6 M   213.4 DEG  4.43 M/SEC  24008.2 M   212.9 DEG     3.81 M/SEC
  8   1200 CST  4287112N.  743621E.  4207.7 M   213.1 DEG  4.68 M/SEC  28215.9 M   212.9 DEG     3.92 M/SEC
  9   1215 CST  4290607N.  745677E.  4054.7 M   210.5 DEG  4.51 M/SEC  32270.6 M   212.5 DEG     3.98 M/SEC
 10   1230 CST  4294157N.  746858E.  3741.2 M   198.4 DEG  4.16 M/SEC  36011.9 M   211.[illegible] DEG     4.00 M/SEC
 11   1245 CST  4297350N.  747505E.  3258.0 M   191.4 DEG  3.62 M/SEC  39269.9 M   209.5 DEG     3.97 M/SEC
 12   1300 CST  4300390N.  748350E.  3155.5 M   195.5 DEG  3.51 M/SEC  42425.4 M   208.5 DEG     3.93 M/SEC
 13   1315 CST  4303457N.  749383E.  3236.1 M   198.6 DEG  3.60 M/SEC  45661.4 M   207.3 DEG     3.90 M/SEC
 14   1330 CST  4306026N.  749765E.  2597.1 M   188.5 DEG  2.89 M/SEC  48258.5 M   [illegible] DEG     3.83 M/SEC
 15   1345 CST  4308615N.  749751E.  2591.6 M   179.9 DEG  2.88 M/SEC  50850.1 M   [illegible] DEG     3.77 M/SEC
 16   1400 CST  4311290N.  749684E.  2673.3 M   178.3 DEG  2.97 M/SEC  53523.4 M   [illegible] DEG     3.72 M/SEC
 17   1415 CST  4313281N.  749967E.  1999.4 M   188.3 DEG  2.22 M/SEC  55522.8 M   [illegible] DEG     3.63 M/SEC
 18   1430 CST  4314981N.  750153E.  1723.8 M   189.6 DEG  1.92 M/SEC  57246.6 M   [illegible] DEG     3.53 M/SEC
 19   1445 CST  4316807N.  750218E.  1927.4 M   182.0 DEG  2.03 M/SEC  59074.0 M   [illegible] DEG     3.45 M/SEC
 20   1500 CST  4319518N.  750010E.  1923.2 M   173.5 DEG  2.03 M/SEC  60897.2 M   [illegible] DEG     3.38 M/SEC
 21   1515 CST  4320290N.  749534E.  1739.4 M   164.1 DEG  1.93 M/SEC  62635.6 M   [illegible] DEG     3.31 M/SEC
 22   1530 CST  4320437N.  749084E.   473.7 M   108.1 DEG  0.53 M/SEC  63109.2 M   [illegible] DEG     3.19 M/SEC
 23   1545 CST  4313694N.  749623E.  1803.7 M    14.8 DEG  2.00 M/SEC  64913.0 M   [illegible] DEG     3.14 M/SEC
 24   1600 CST  4318606N.  747379E.  1247.1 M    86.0 DEG  1.39 M/SEC  66160.1 M   [illegible] DEG     3.06 M/SEC
 25   1615 CST  4319877N.  746464E.  1555.0 M   144.8 DEG  1.73 M/SEC  67715.0 M   [illegible] DEG     3.01 M/SEC
 26   1630 CST  4322341N.  746253E.  2473.4 M   174.9 DEG  2.75 M/SEC  70188.4 M   197.[illegible] DEG     3.03 M/SEC
 27   1645 CST  4326055N.  745908E.  3731.1 M   174.5 DEG  4.15 M/SEC  73919.5 M   195.7 DEG     3.04 M/SEC
 28   1700 CST  4330640N.  745806E.  4585.5 M   178.7 DEG  5.10 M/SEC  78505.0 M   194.5 DEG     3.12 M/SEC
 29   1715 CST  4335437N.  745876E.  4797.9 M   180.8 DEG  5.33 M/SEC  83302.9 M   193.7 DEG     3.19 M/SEC
```

are apparant afterwards. These changes could either be spacial or time related in nature, that is, either the wind deviations are caused by the air parcel's movement into an area where the representative winds are different or by some moving meteorological phenomena that has changed the entire wind field. The answer to this question would have been provided by a series of trajectories all initiated at the tracer release point, but begun at uniformly spaced times throughout the period of the tracer release. Only if the trajectory is not affected by a wind field changing in time can the tracer results be truly applied to a Gaussian representation.

It appears that the tracer comparison partially documents the accuracy of the EQR trajectory mode. Adequate documentation of the speed of air parcel motion can be answered in subsequent tests where discrete emissions are monitored downwind. The capabilities of the model to monitor diverse meteorological phenomenon will be discussed in the next chapter.

SECTION 8

PROJECT RESULTS

THE TRAJECTORY TASKS

In conjunction with the work of several investigators it was recommended that EQR's expertise in providing local trajectories in the St. Louis area be utilized. The first formal request was made to EQR by EPA scientists on March 10, 1976 that two days, July 23, and 24, be the object of special study from the summer 1975 EPA intensive study periods and that local trajectories be produced for two sites at 4-hour intervals.

An additional request was formulated to EQR to produce a similar product for two arrival times on July 17 and 18 each for 9 separate sites. A third request for four foreward trajectories was provided through direct communication with Dr. Frederick Shair, whose tracer study was discussed in Section 7.

The composite effort by EQR entailed

1. The acquisition of 5 RAMS minute tapes, each with 10 days of both air quality and meteorological data.
2. The development of the technique to directly utilize this magnetic tape version of RAMS minute data in the trajectory model for both 1-minute and 15-minute trajectories and for both the foreward and backward modes.
3. The completion of the 50 trajectories tasks as discussed above and as detailed in Table 12.
4. The compilation of the Final Report according to EPA guidelines, documenting the development of the trajectory product, its application to the specific cases as defined in Table 12, and its adaptation and use for future experiments.

The 50 trajectory outputs are presented in the Appendix in the order of their listing in Table 12. The tabular summary sheet for each case is included in the Appendix and follows each gridded trajectory depiction.

TABLE 12. THE DESCRIPTION OF THE 50 TRAJECTORIES PRODUCED BY THE OBJECTIVE MODEL FOR CASES DURING THE EPA 1975 SUMMER INTENSIVE

	Endpoint Location	Start Time (CST)	End Time (CST)	Mode	No Steps	Ave Motion (deg/m sec^{-1})	DATE
1	RAMS 106	2000	1530	Backward	18	192.1°/2.94	July 17
2	" 111	"	1545	"	17	188.7°/2.76	"
3	" 105	"	1515	"	19	191.4°/2.88	"
4	" 104	"	1515	"	19	192.2°/2.81	"
5	" 102	"	1500	"	20	190.9°/3.07	"
6	" 108	"	1100	"	36	195.7°/2.80	"
7	" 121	"	0945	"	41	191.2°/2.68	"
8	" 122	"	0800	"	48	204.1°/3.04	"
9	" 123	"	1130	"	34	197.8°/2.69	"
10	" 106	0800	0245	"	21	181.6°/2.51	July 18
11	" 111	"	0330	"	18	180.9°/2.54	"
12	" 105	"	0245	"	21	178.1°/2.43	"
13	" 104	"	0230	"	22	172.6°/2.46	"
14	" 102	"	0200	"	24	184.2°/2.70	"
15	" 108	"	0115	"	27	180.3°/2.69	"
16	" 121	"	0045	"	29	184.1°/2.78	"
17	" 122	"	2000	"	48	211.7°/2.73	July 17-18
18	" 123	"	0230	"	22	182.4°/2.82	July 18
19	City #2	1900	1215	"	27	109.0°/2.09	July 22
20	" #1	"	1400	"	20	107.9°/2.49	"
21	" #2	2300	1615	"	27	102.6°/1.99	"
22	" #1	"	1630	"	26	100.0°/1.89	"
23	" #2	0300	1915	"	31	119.0°/2.03	July 22-23
24	" #1	"	1900	"	32	119.2°/1.74	"
25	" #2	0700	0115	"	23	140.2°/2.25	July 23
26	" #1	"	2300	"	32	136.3°/2.04	July 22-23
27	" #2	1100	0815	"	11	171.9°/3.59	July 23
28	" #1	"	0715	"	15	175.5°/3.40	"
29	" #2	1500	1200	"	12	176.9°/3.55	"
30	" #1	"	1130	"	14	175.9°/3.76	"
31	" #2	1900	1630	"	10	201.8°/4.62	"
32	" #1	"	1545	"	13	198.9°/4.19	"
33	" #2	2300	1900	"	16	229.6°/4.33	"
34	" #1	"	1815	"	19	229.0°/4.65	"
35	" #2	0300	2215	"	19	264.4°/3.63	July 23-24
36	" #1	"	2200	"	20	262.6°/3.78	"
37	" #2	0700	0145	"	21	259.5°/3.11	July 24
38	" #1	"	0145	"	21	260.9°/3.37	"
39	" #2	1100	0515	"	23	285.5°/3.48	"
40	" #1	"	0430	"	26	282.9°/3.47	"
41	" #2	1500	0700	"	32	319.2°/2.92	"
42	" #1	"	0900	"	24	330.3°/3.04	"
43	" #2	1900	1215	"	27	346.8°/2.94	"
44	" #1	"	1300	"	24	347.8°/2.75	"
45	" #2	2300	1500	"	32	358.4°/2.23	"
46	" #1	"	1515	"	31	356.8°/2.11	"
47	RAMS 111	1000	1745	Foreward	31	134.2°/2.89	Aug 8
48	KETC tower	1000	1715	"	29	193.7°/3.19	Aug 11
49	Webster Col.	2000	2300	"	12	183.8°/5.85	Aug 12
50	RAMS 111	1000	1900	"	36	338.4°/1.80	Aug 15

THE CASES AND THEIR METEOROLOGY

The period selected for the production of the 50 trajectories coincided, of course, with the 1975 Summer EPA intensive and therefore only represents a few of the meteorological types that influence the St. Louis urban area. The integration of mesoscale wind data from the RAMS network was accomplished automatically using the trajectory program modified to accept 1-minute RAMS data on magnetic tape. This improved trajectory model derived detailed surface air parcel movements for the periods required.

Most of the cases selected in this July-August test period were akin to the climatological norm in which southerly winds prevail. It is not uncommon for winds between 220° and 140° to persist for several days during the summer months. It is also not uncommon for convective disturbances to develop during these conditions of moist southerly flow. These produce wind shifts which invalidate the assumptions of steady-state, uniform flow which are needed in most of the experiments to support modeling efforts under investigation during the EPA intensive.

The 50 trajectories take place during three separate meteorological periods:

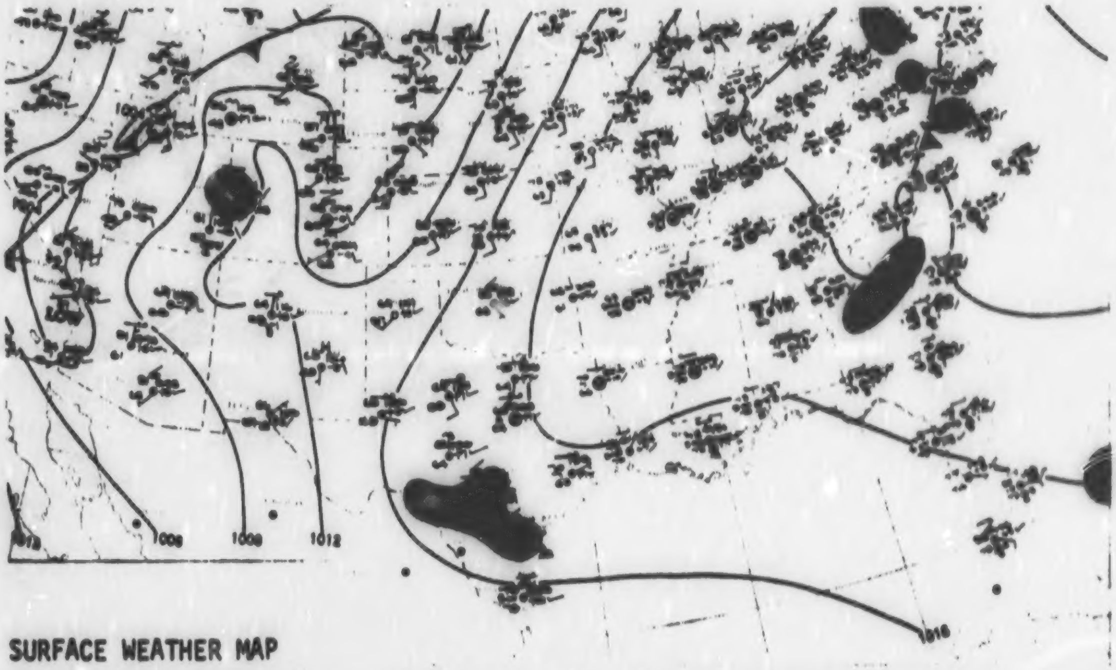
1. July 17-18 (steady southerly winds)
2. July 22-24 (shifting winds, E to S to W to N)
3. Aug 8-15 (steady southerly winds)

Each weather regime can be correlated to the trajectory patterns that were produced using local surface wind data.

Period 1 July 17-18

The period of weather from July 14 through July 20 evolved during a strong entrenchment of the Bermuda high pressure zone off the East Coast of the United States. The resultant weather in the central United States consisted of steady southerly winds, interrupted only with the occasional passage of a line of rain showers.

Figures 11, 12, and 13 are the surface weather maps for the mornings of July 16, 17, and 18. Each shows a report of southerly winds at St. Louis. The long range trajectory is from SSE, with the air over St. Louis on the 18th originating from near the northern Alabama border two days prior.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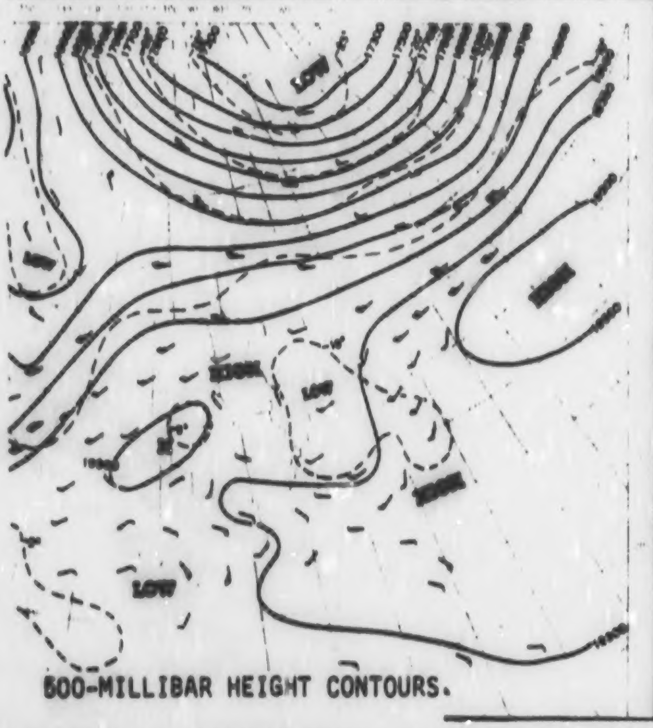
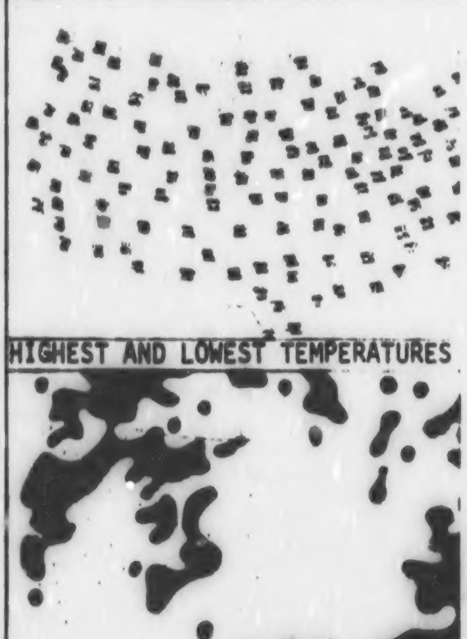
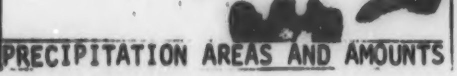
SURFACE WEATHER MAP



500-MILLIBAR HEIGHT CONTOURS.

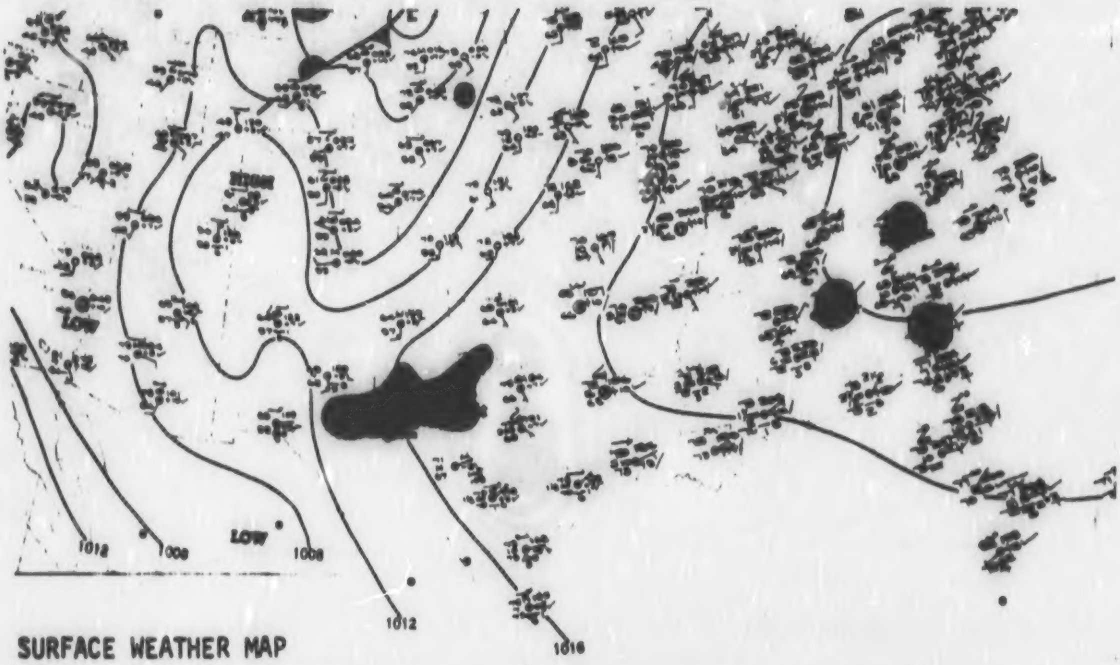


HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 11. WEATHER MAPS FOR 0600 CST, JULY 16, 1975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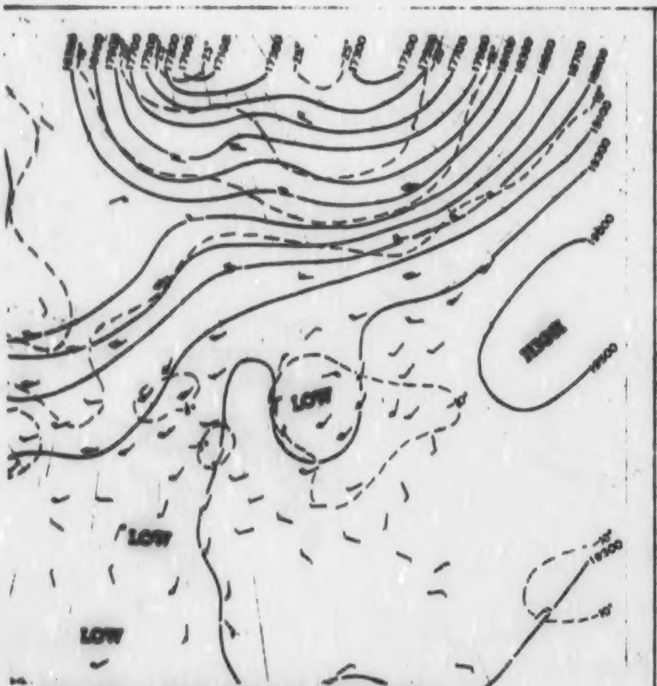
SURFACE WEATHER MAP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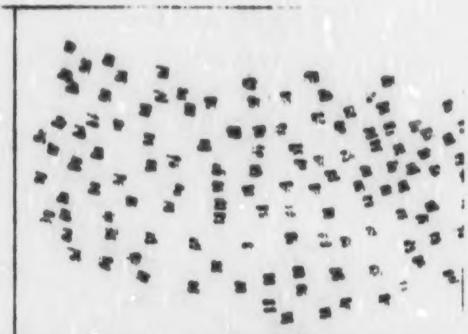
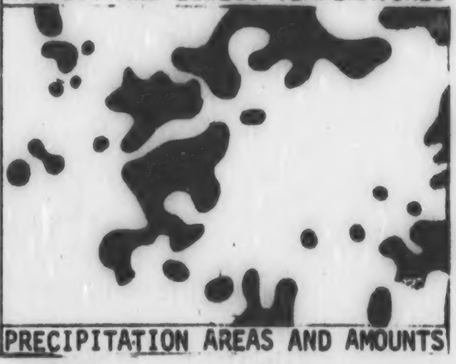
500-MILLIBAR HEIGHT CONTOURS

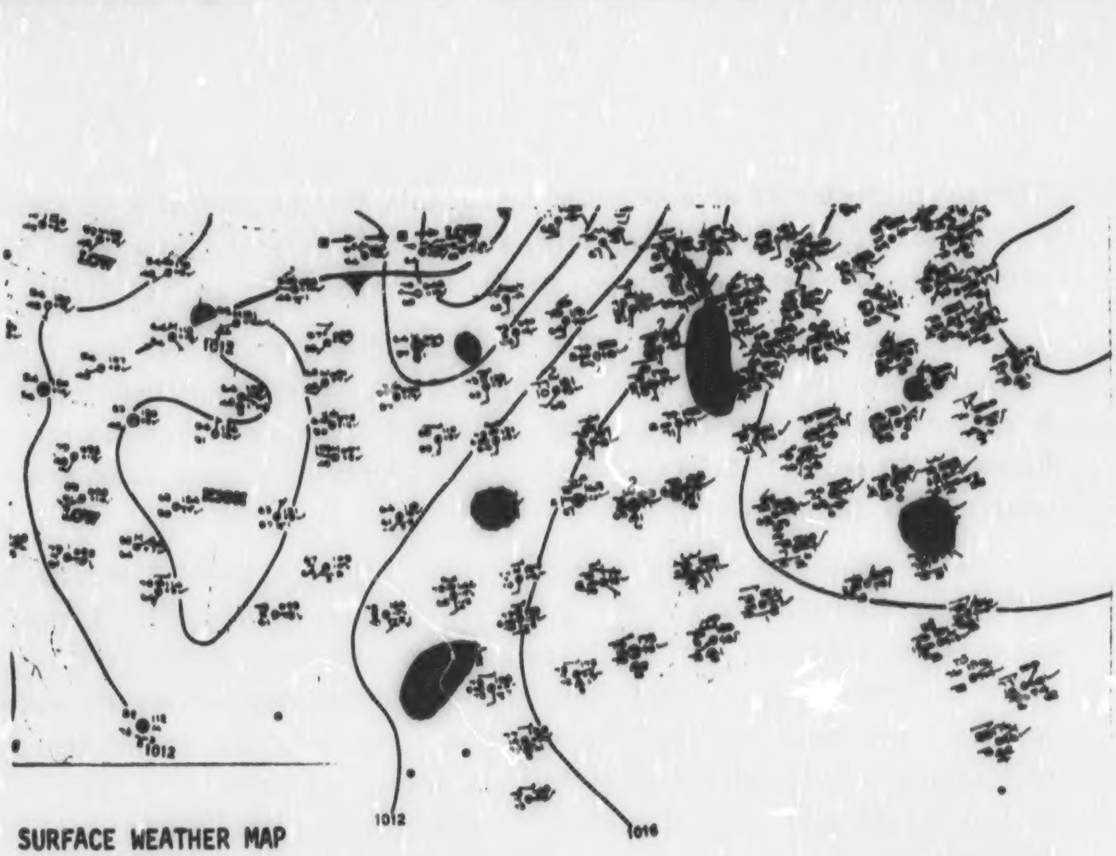


HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 12. WEATHER MAPS FOR 0600 CST, JULY 17, 1975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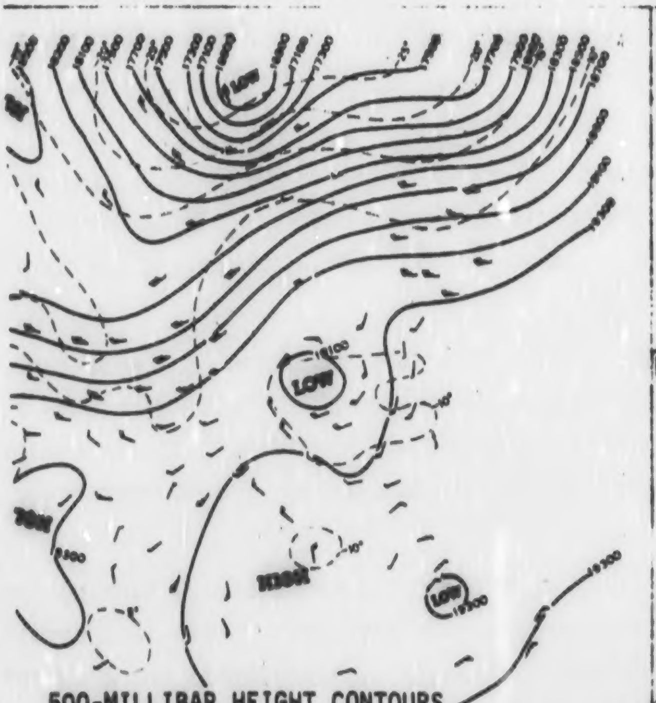
SURFACE WEATHER MAP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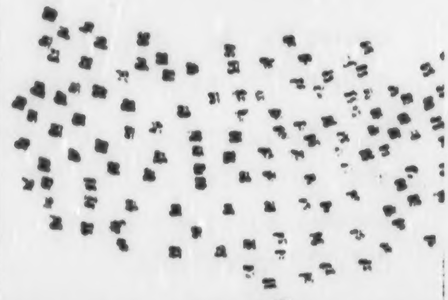
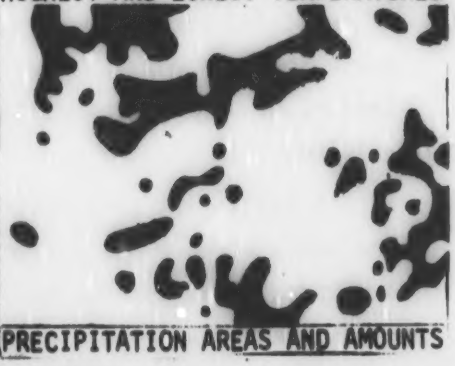
500-MILLIBAR HEIGHT CONTOURS



HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 13. WEATHER MAPS FOR 0600 CST, JULY 18, 1975

Eighteen trajectories were selected during this 48-hour period, nine ending at 2000 CST, July 17, and nine ending at 0800 CST, July 18. Nine sites were selected covering the entire range of the RAMS network as arrival sites.

Pages 108 through 116 in the Appendix describe trajectories long enough to incorporate the passage of a line of showers through the St. Louis area. A National Weather Service report of .06 inches of precipitation was recorded between 1400 and 1500 CST on July 17 at Lambert Field, located about midway between RAMS 120 and 121.

Referring to the tabular data describing the trajectories 6 through 9, each notes the initiation of the squall line passage as 1400 CST. Typical of an air mass instability line is the eventual return to southerly flow after the line passes. In this case four 15-minute steps reflect the west-northwest outflow of air from the meso-high produced by the line of showers. Each case also reflects the significant convergence into the line that evolves as the showers develop over the metropolitan area. Trajectory 8, whose air parcel path intersects the squall line west of the urban area, is not preceeded by significant inflow. The rate of change of development of convective activity can be inferred by a set of synoptic trajectories originating at uniformly spaced locations.

An additional perturbation is captured in the trajectories 1 through 9 that initiates at 1615 CST. No precipitation is recorded at the official Weather Service guage for the system or at any other time during the period July 17 to July 18.

The weather map, Fig. 13 for July 18 at 0600 CST, shows the appearance of a stipled area along the Illinois - Indiana border. This represents a north-south line of showers and is indicated by rain falling at the Evansville, Indiana, Weather Service station and by the conclusion of a thundershower at Chicago, Illinois.

Trajectories 10 through 18 in the Appendix shows a steady turning during the early morning hours from southerly to southwesterly. This is a normal occurance after sunrise for the winds to begin to approximate the gradient winds that parallel the orientation of the isobars in Fig. 13. Both of the trajectories ending at the most northerly RAMS Station, 122, fail to exit the bounds of the regional grid and consume the entire allotted 12 hours of minute RAMS data. The other trajectories automatically terminated after approaching within five kilometers of the grid boundaries.

Period 2 July 22-24

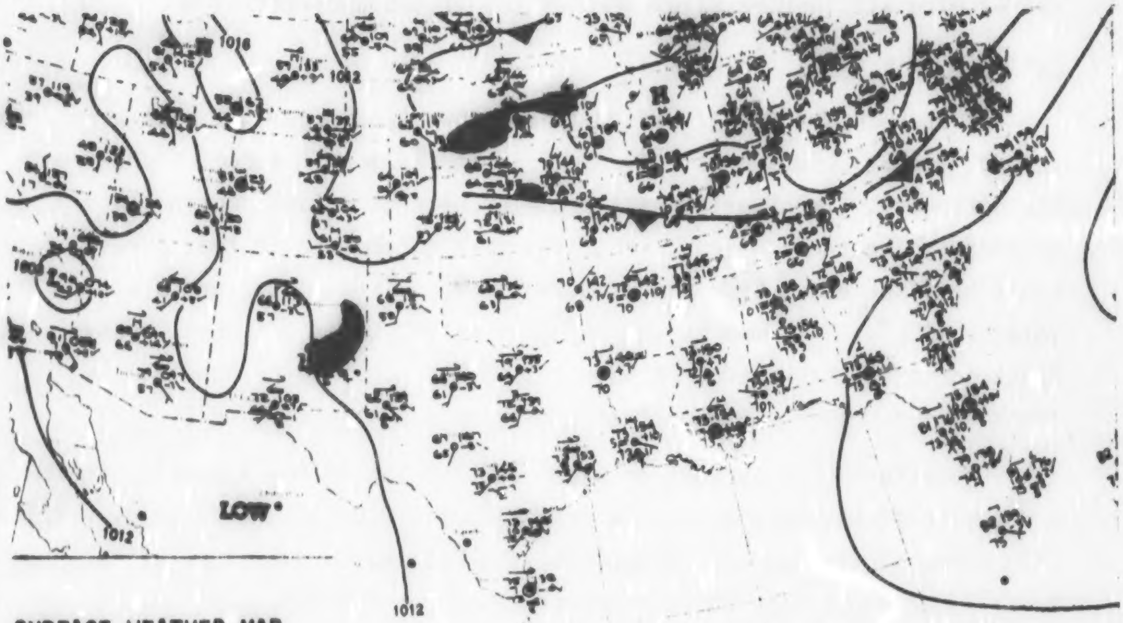
Figures 14 through 17 depict the northwest passage of a weak warm front through the St. Louis area and a subsequent passage of a cool front from the northwest. Twenty-eight trajectories were calculated during this period of changing weather. Air parcel paths were determined so that arrival times would be fixed every four hours at two sites. These locations are near the intersection of 14th and Market in downtown St. Louis and near Broadway and Hurck in the southern edge of St. Louis City. They correspond to the locations of the City Air pollution network's stations 1 and 2.

Trajectories 19 and 20, on pages 135 and 138 in the Appendix, indicate a steady east-southeasterly flow from 1215 to 1900 CST. Figure 14, despite calm winds at the surface at 0600 CST the morning of July 22, indicates an easterly gradient flow which corroborates the trajectory.

By the time Fig. 15 is valid, at 0600 CST July 23, both the trajectories and the surface wind at Lambert Field coincide. The showers that appear in Iowa have not passed through the St. Louis area prior to the map time of Fig. 15 either in the form of precipitation or in the form of a wind shift that would be documented in the trajectory products.

However, as the day passes, .03 inches of convective precipitation occurs at the Weather Service gauge in the northwest portion of the city between the hours 0900 and 1000 CST. No indication of wind shifts occur in trajectories 27 or 28. It is probable that, due to the orientation of the geostrophic winds above the boundary layer, the convective elements were moving to the northeast and did not propagate into the southern portions of the grid.

An additional shower was reported between 1300 and 1400 CST, dropping .10 inches of rain. Trajectories 29 and 30 contain both directional and speed irregularities that are likely attributable to this system of showers. The trajectory that reaches the downtown St. Louis area shows a marked shift at 1345 CST. Both trajectories depict a marked slow-up of the wind as the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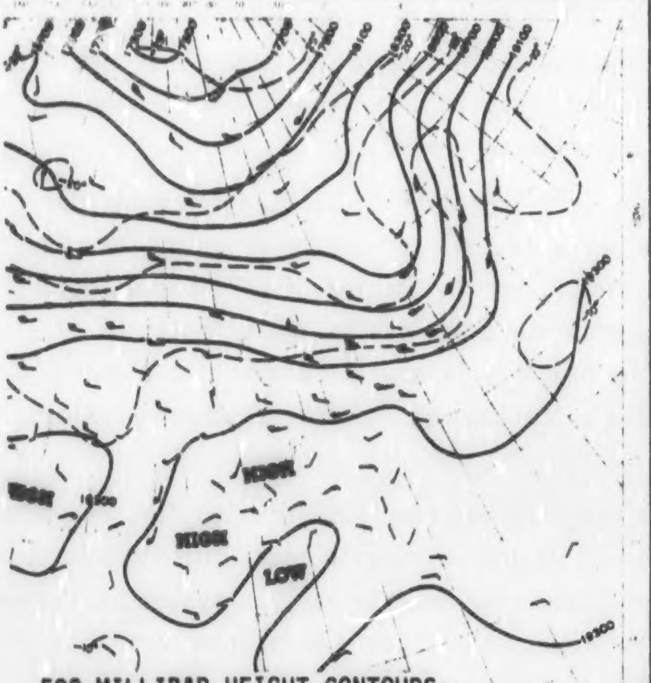
SURFACE WEATHER MAP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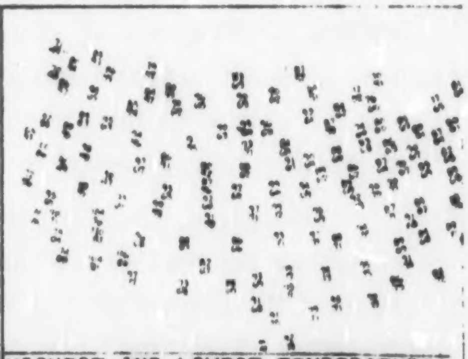
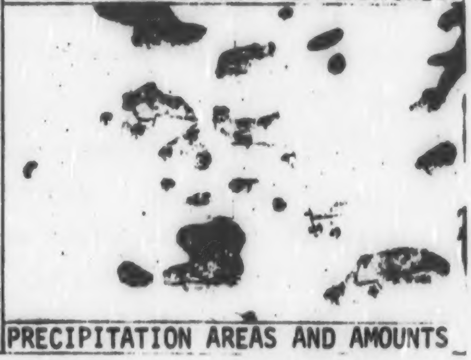
500-MILLIBAR HEIGHT CONTOURS

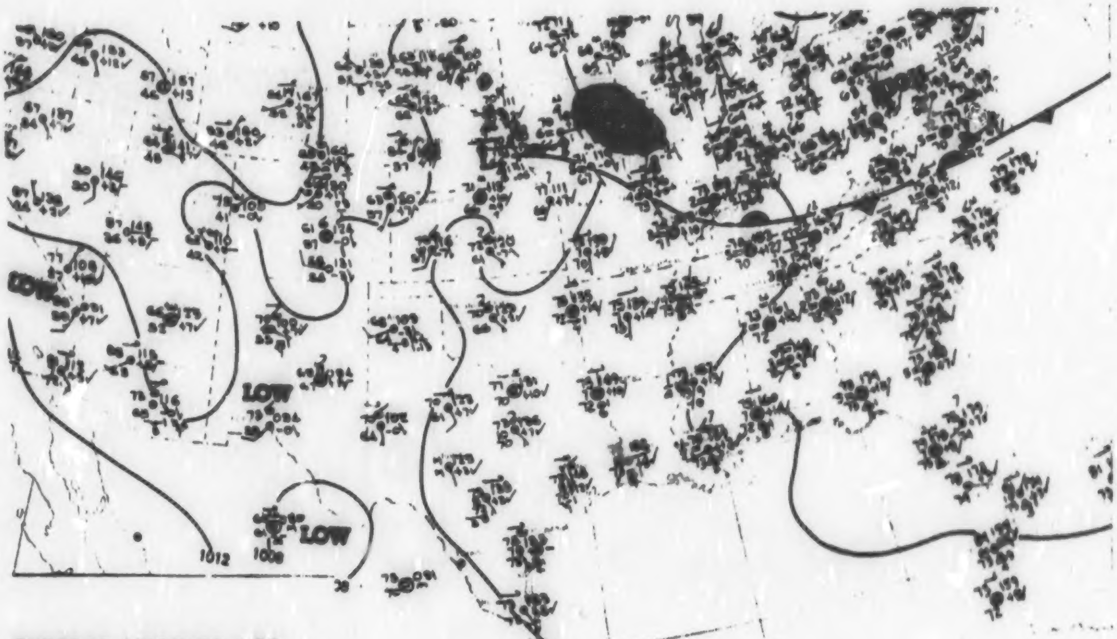


HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 14. WEATHER MAPS FOR 0600 CST, JULY 22, 1975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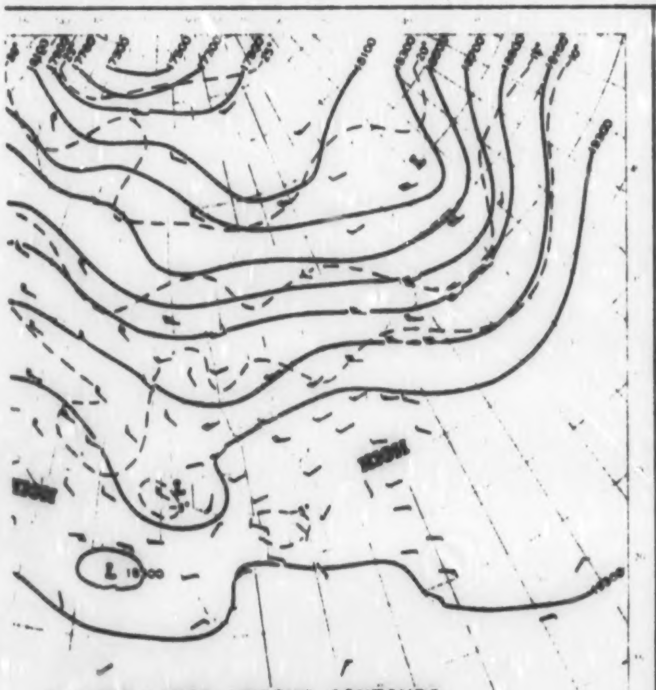
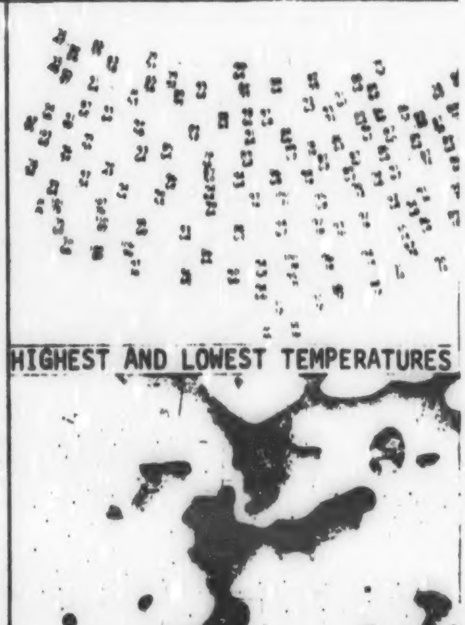
SURFACE WEATHER MAP



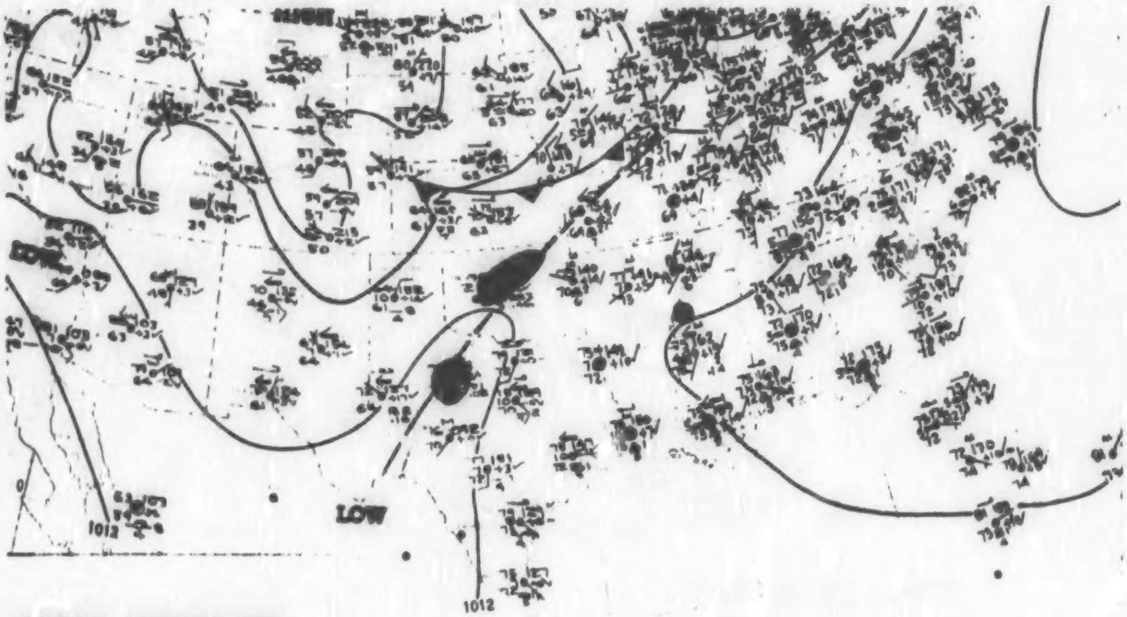
500-MILLIBAR HEIGHT CONTOURS



HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

FIGURE 15. WEATHER MAPS FOR 0600 CST, JULY 23, 1975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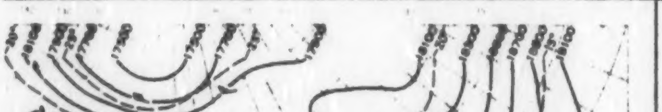
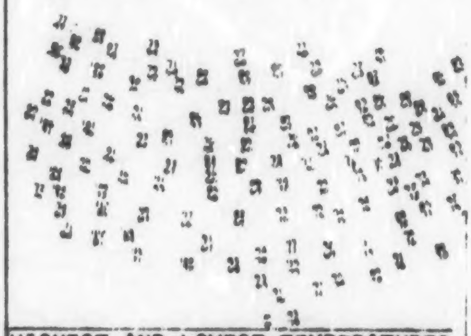
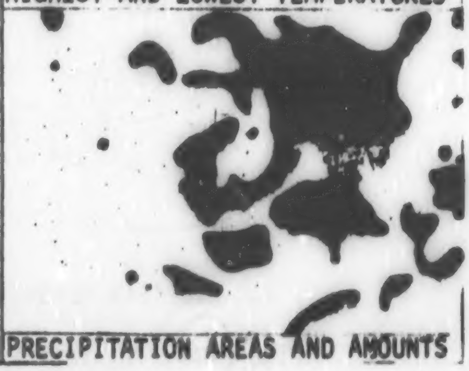
SURFACE WEATHER MAP



500-MILLIBAR HEIGHT CONTOURS

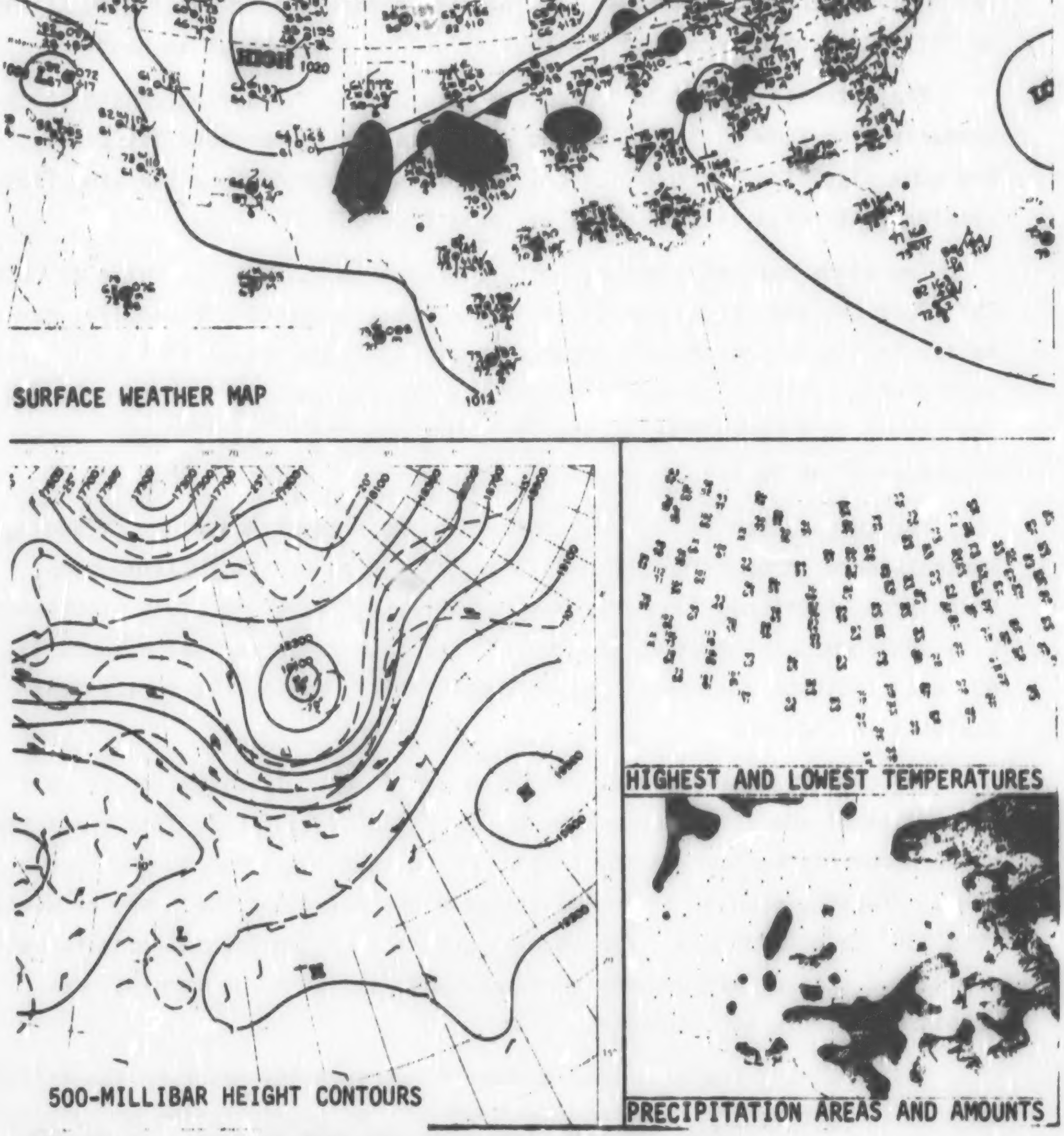


HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 16. WEATHER MAPS FOR 0600 CST, JULY 24, 1975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SURFACE WEATHER MAP

500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

FIGURE 17. WEATHER MAPS FOR 0600 CST, JULY 25, 1975

showers are passing through. Trajectories 31 and 32 indicate a slight turn in the gradient wind from the southwest and a typical return to moderate wind speeds.

A third shower element passed the official measuring site at the Weather Service office at Lambert between 2100 and 2200 CST depositing .07 inches of rain. Trajectories 33 and 34 both indicate a marked turning at 2100 CST and an initiation of a return to southwesterly flow after about an hour.

Trajectories 35 and 36 indicate a substantial disruption of the southwesterly wind flow at 2330 CST. No precipitation is recorded officially, but some significant meteorological feature has passed since the wind flow remains west-northwesterly until at least 0300 CST.

The winds derived from the surface weather map, Fig. 16, valid at 0600 CST, July 24, and the trajectories in the Appendix pages 172 and 174, correlate in time. The dry convergence zone that is portrayed in Fig. 16 just east of Evansville, Indianapolis, and Fort Wayne, Indiana, seems to be the phenomenon that correlates to the St. Louis wind shift at 2330 CST, shown on trajectories 35 and 36.

The surface map in Fig. 16 depicts the weak cold front that is moving southeastward through the State of Missouri. A second convergence zone, unanalyzed, stretches from just west of Abilene, Texas, to south of Oklahoma City, Oklahoma, to north of St. Louis. The four trajectories, numbers 37-40, each indicate a windshift at 0630 CST, thirty minutes later than the analysis in Fig. 16.

The cool frontal passage, with a switch to northly winds, occur by the completion of the trajectories number 39 and 40 at 1100 CST. The winds seem to turn northly earlier on the trajectory 40 that is closer to the frontal zone. However, each of these two trajectories calculate the onset of winds from 330° to be 0930 CST. The thermal gradient of the frontal zone is weak, typical of summer, and, because of its passage early in the morning, was devoid of rain shower activity.

The remaining trajectories, numbers 41 through 46, describe the influx of cool air carried by light northerly winds. No precipitation or convective elements of note occurred after the frontal passage. As is indicated by

Fig. 17 on the morning of July 25, the front's southward push was halted barely 150 miles south of St. Louis.

This series of trajectories offers a rare opportunity to study the mesoscale meteorology comprising a complex but common weather phenomenon. Time continuity of this type offers a keen insight into the interpretation and analysis of larger scale data and, of course, defines the carrier of the air pollution parameters that were under study during the 1975 summer EPA intensive.

Period 3 Aug 8-15

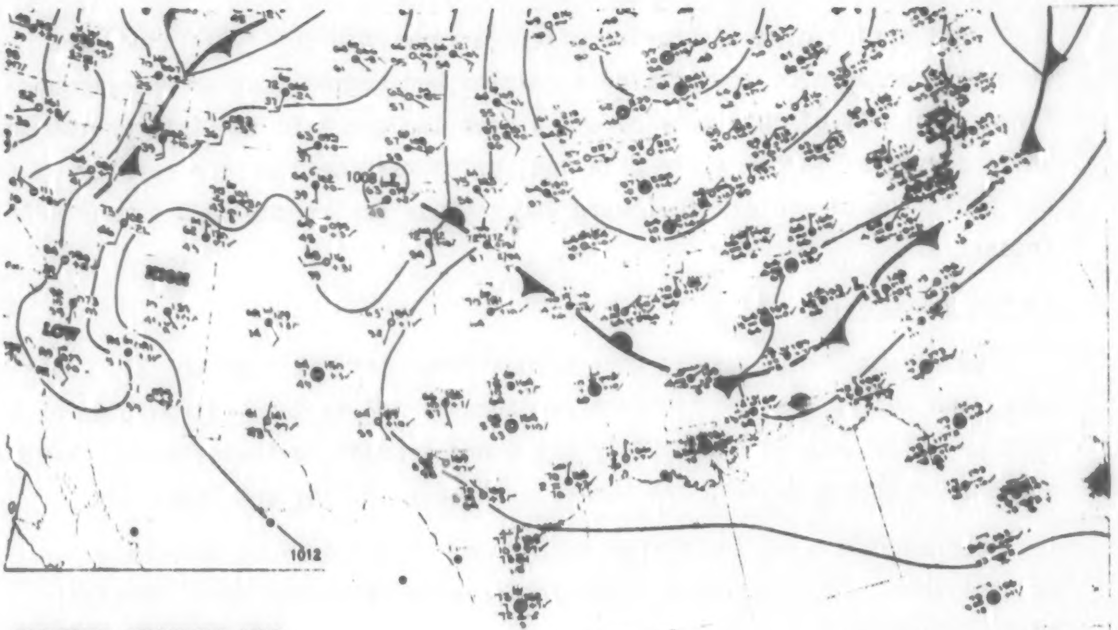
Between the days Aug 6, when a cool front past through the St. Louis area, and Aug 16 eastern Missouri remained in the western extremities of a high pressure zone with southerly winds and increasing humidities. Airmass showers developed late in the period on August 13, 14, and 15th.

During this week the tracer studies described in Section 7 were accomplished. Four foreward trajectories were requested that correlated to SF_6 releases. The results of one of these releases was discussed in the aforementioned section.

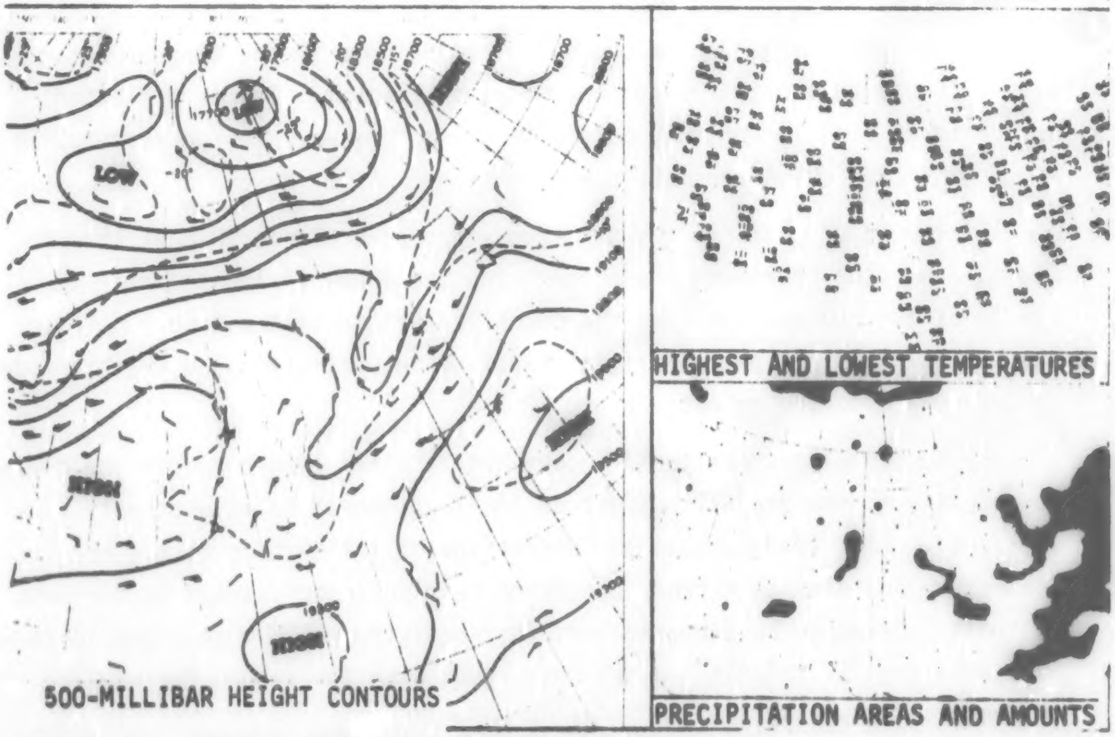
Trejectory number 47 indicates a peculiar turn in the wind around 1200 CST. No precipitation accompanied this feature. The surface winds indicated in Fig. 19 for 0600 CST correlates quite well to the southeasterly movement of the calculated air parcel motion.

It should be noted in the trajectory products 47 and 50 that the legend now reads "foreward trajectory" and the ★ now is located near the center of the regional grid at the specified origin of the tracer release. The designation "air parcel origin" has also been repositioned in this mode to correspond to the release point.

By Aug 10 widely scattered shower activity has been noted in the Midwest correlating to the gradual buildup of low level moisture as southerly flow continued. Fig. 20 describes the conditions on the morning of Aug 10. Convective activity is already occurring from northeast Kansas to northern Illinois. It would be expected that this activity would move close to the St. Louis area by late in the day coincident with the second foreward trajectory, number 48.


HIGH
LOW
1008
1012

SURFACE WEATHER MAP

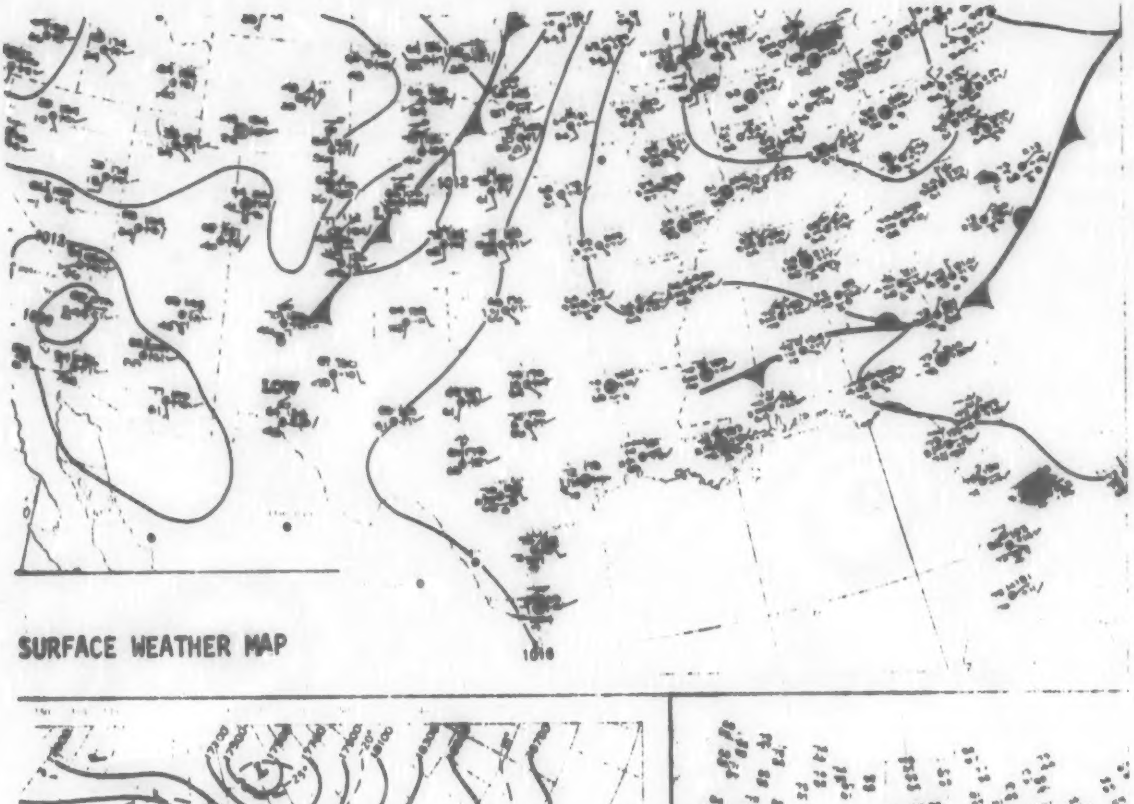

LOW
LOW
HIGH
HIGH
17700
-20°

500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

FIGURE 18. WEATHER MAPS FOR 0600 CST, AUGUST 7, 1975



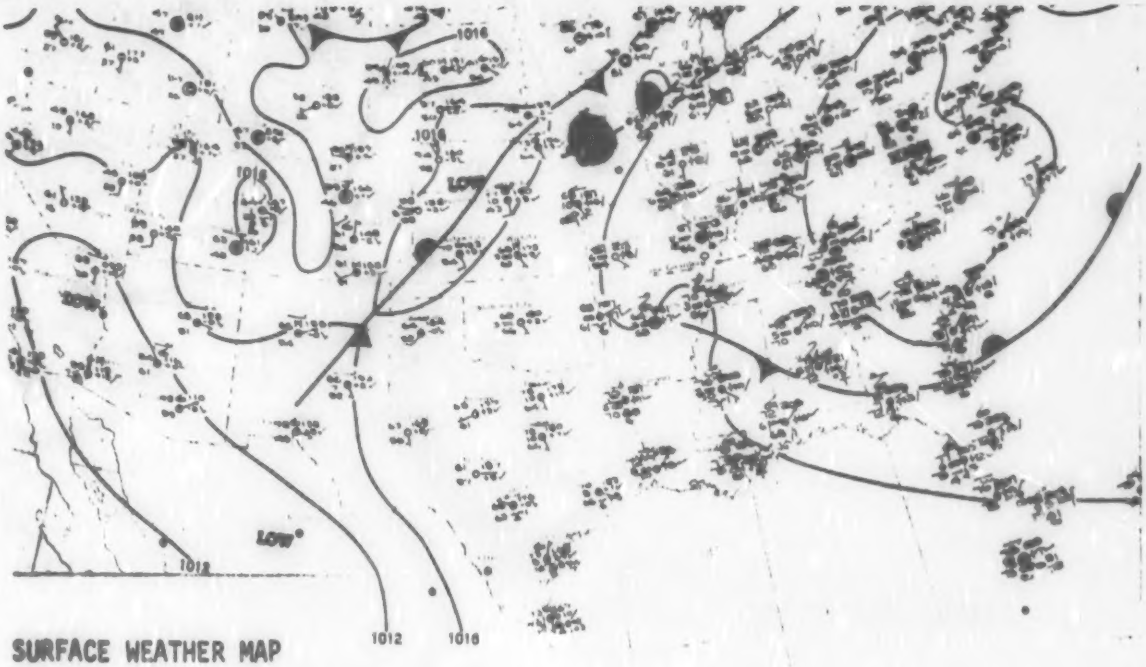
SURFACE WEATHER MAP

500-MILLIBAR HEIGHT CONTOURS

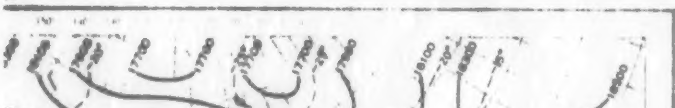
HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

FIGURE 19. WEATHER MAPS FOR 0600 CST, AUGUST 8, 1975

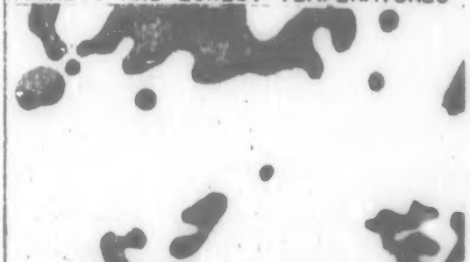

1016
1018
1018
LOW
LOW
LOW
1012
1012
1016

SURFACE WEATHER MAP


18300
LOW
LOW
HIGH
HIGH
HIGH
LOW
-10°
18300
19300

500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 20. WEATHER MAPS FOR 0600 CST, AUGUST 9, 1975

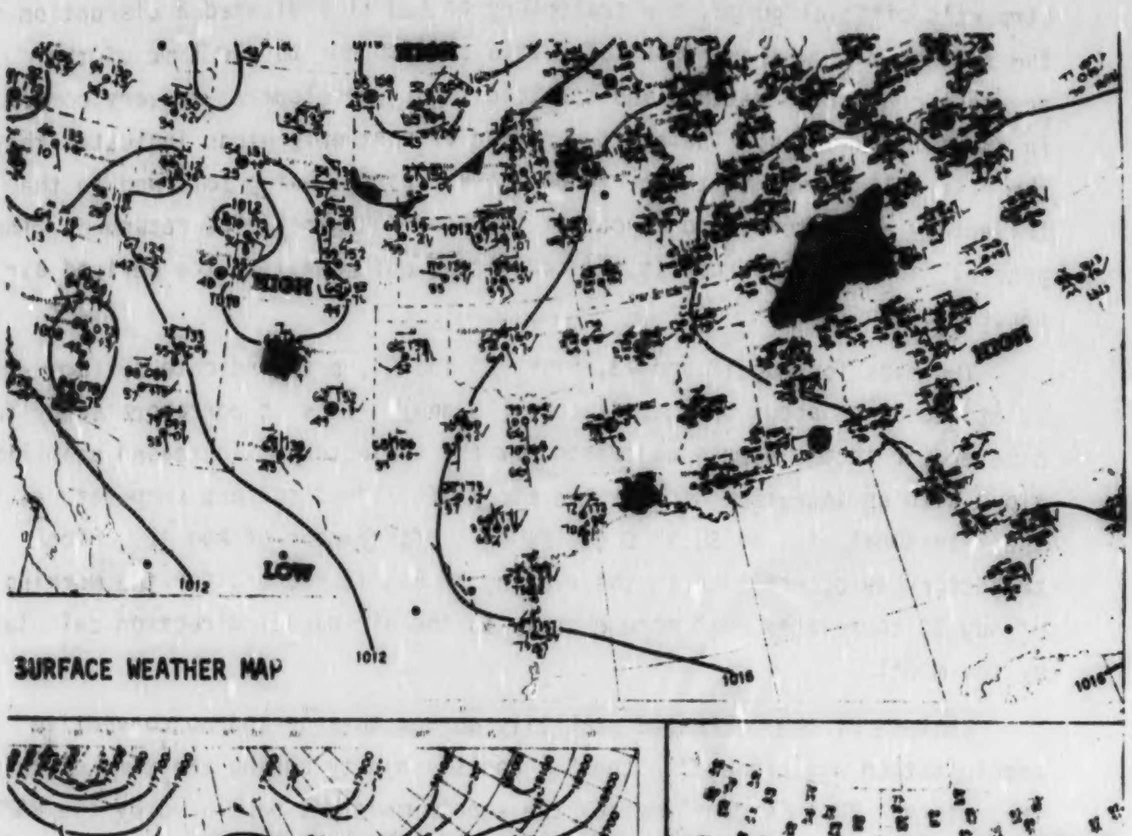
Despite the fact that no precipitation is officially recorded at the airport's official guage, the trajectory on Aug 11 indicated a disruption of the southerly flow about 1545 CST. This corresponds to the time of the greatest convective heating and sporadic shower development is very common in the summer months. The short duration of northerly winds indicates that the rain cell passed to the north of the air parcel being followed in the trajectory and after it moved out of the area southerly flow returned. The general flow indicated by Fig. 22 correlates quite well to the derived air parcel motions.

The maps for Aug 12 and 13, Figs. 23 and 24, both indicate surface winds at St. Louis of about 5 meters/second (10 mph). This is corroborated by the 6 meter per second speeds calculated by the trajectory. Increased stability along with an intrusion of maritime air aloft lifted surface temperatures to their seasonal high of 38.3° C (101F) on the afternoon of Aug 12. Since trajectory 49 occurs late in the evening of Aug 12 the map for the morning of Aug 13 correlates much more closely to the air parcel direction calculated by the model.

Because of the increased stability during this period no convective precipitation was present in the St. Louis vicinity during the time of this trajectory. This is confirmed by the smooth movement generated by the RAMS surface observations. The squall line drawn just to the north of St. Louis in Fig. 24 initiated precipitation and a wind shift at 0900 CST, Aug 13, well after the trajectory was completed.

The last trajectory, number 50, begins four hours after the surface weather map depicted in Fig. 26. From the analysis at 0600 CST, Aug 15, it appears that a northerly wind shift is imminent. The National Weather Service precipitation totals at the airport indicate .49" fell between 1100 and 1200 CST with an additional .07" between 1200 and 1300 CST.

From the data tabulation on page 198 in the Appendix the northerly windshift took place at 1215 CST. From an analysis of the individual RAMS stations it was ascertained that the time of the first northerly wind progressed from before 1000 CST at RAMS 122, to 1115 CST at RAMS 120, to 1200 CST at RAMS 119 to 1315 RAMS 117.


SURFACE WEATHER MAP

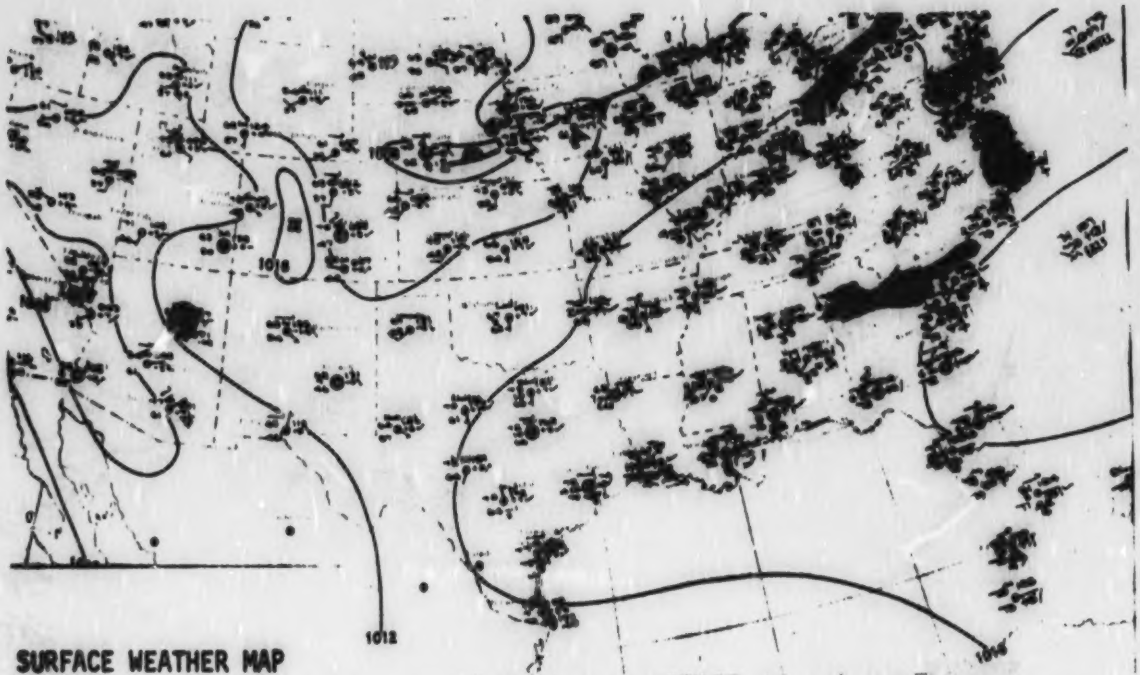
500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

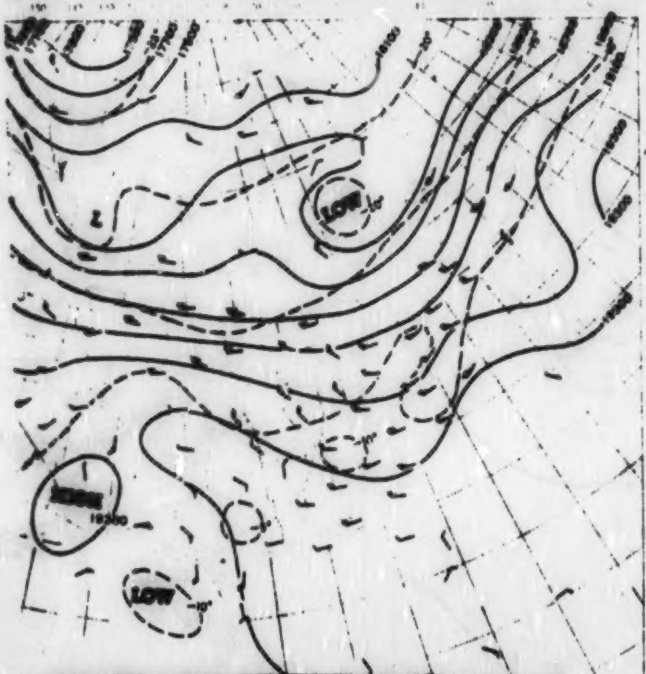
PRECIPITATION AREAS AND AMOUNTS

HIGH
HIGH
HIGH
LOW
LOW
1012
1012
1016
1016
LOW
HIGH
HIGH
19500

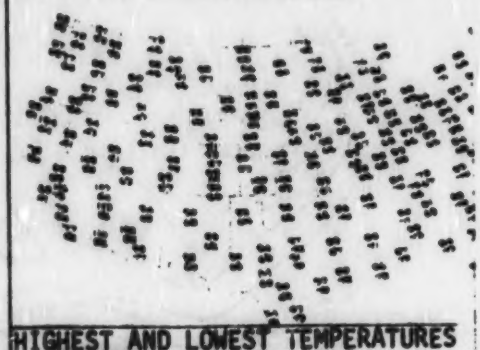
FIGURE 21. WEATHER MAPS FOR 0600 CST, AUGUST 10, 1975


1016
1016
1012
1016

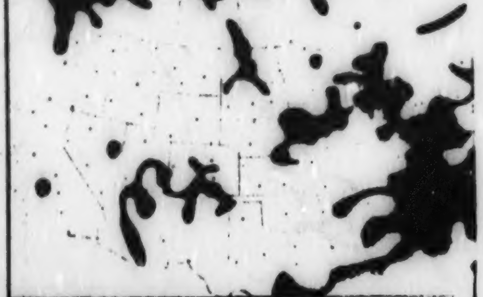
SURFACE WEATHER MAP


LOW
HIGH
LOW

500-MILLIBAR HEIGHT CONTOURS

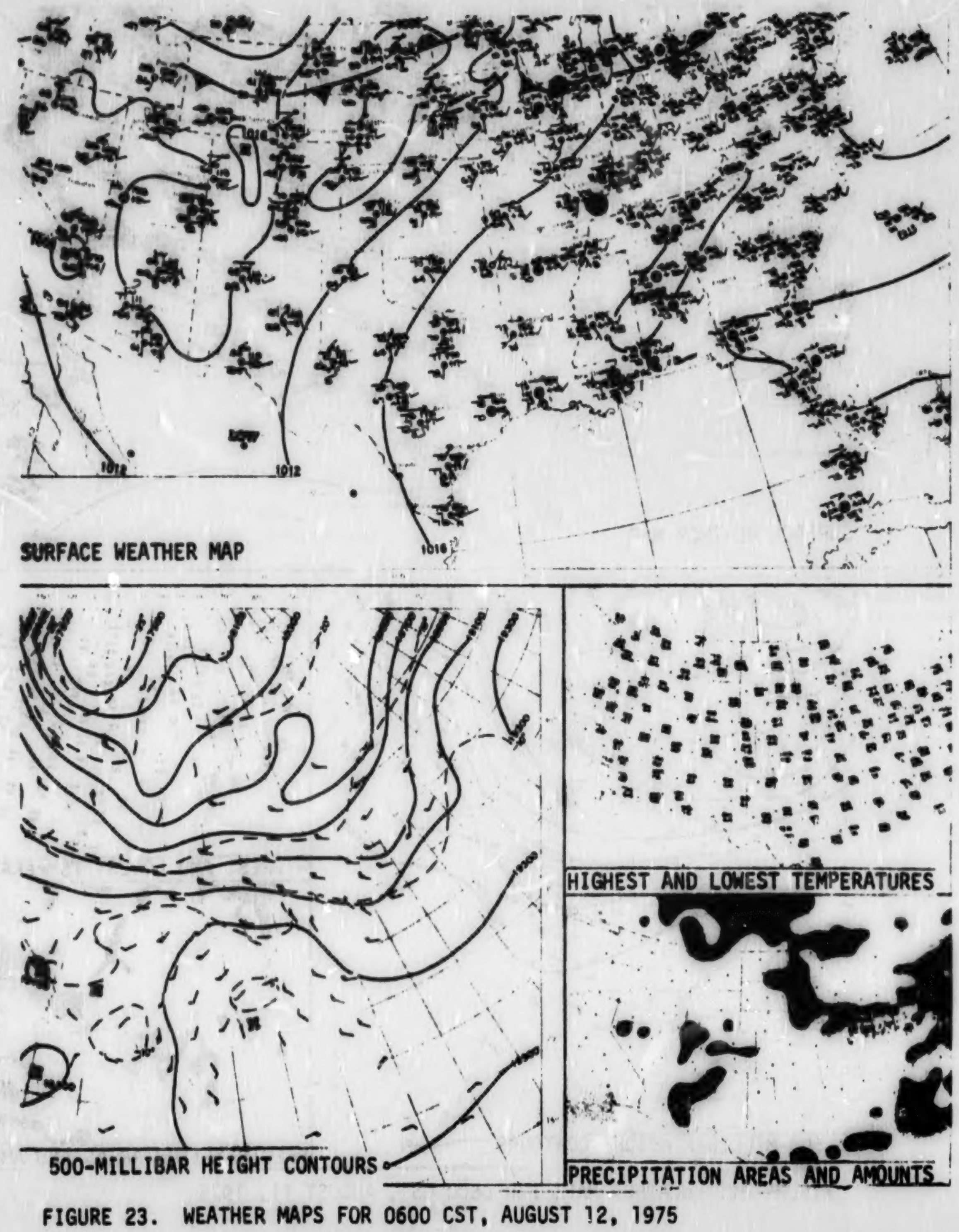


HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 22. WEATHER MAPS FOR 0600 CST, AUGUST 11, 1975



SURFACE WEATHER MAP

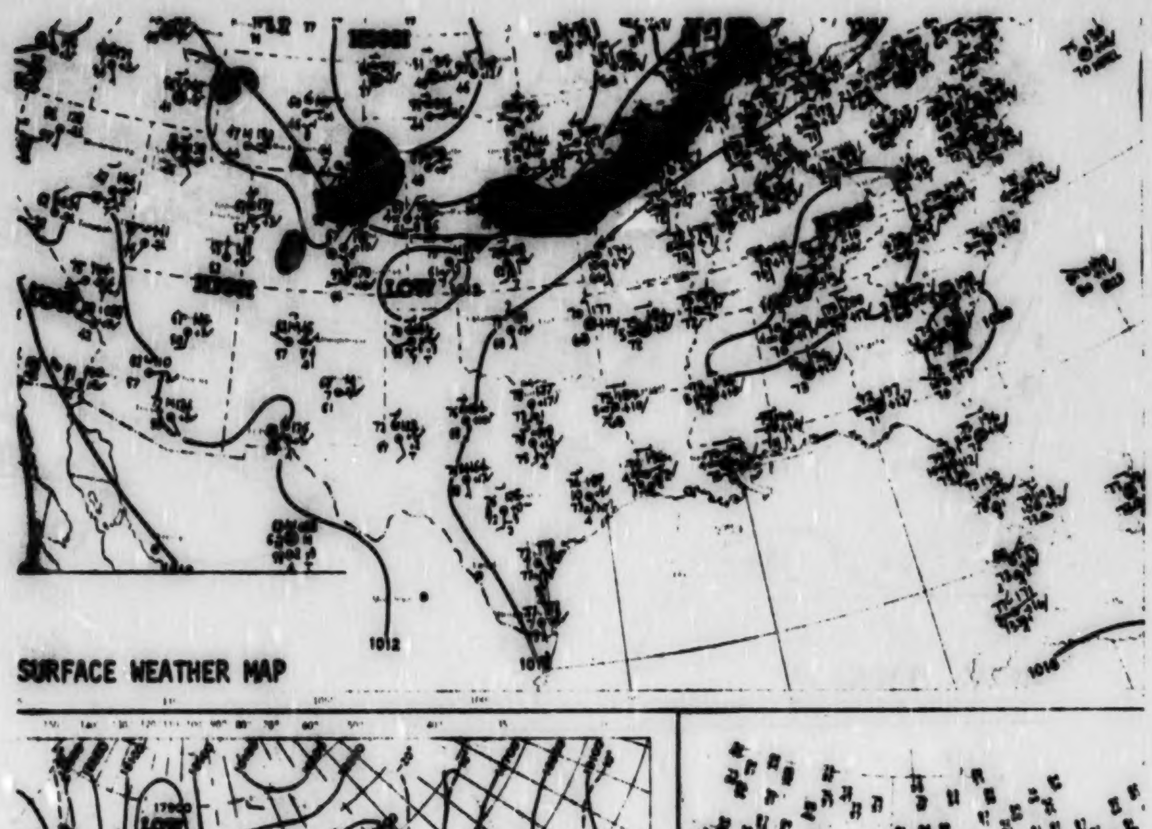
500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

1016
1012
1016
1016
LOW

FIGURE 23. WEATHER MAPS FOR 0600 CST, AUGUST 12, 1975


SURFACE WEATHER MAP

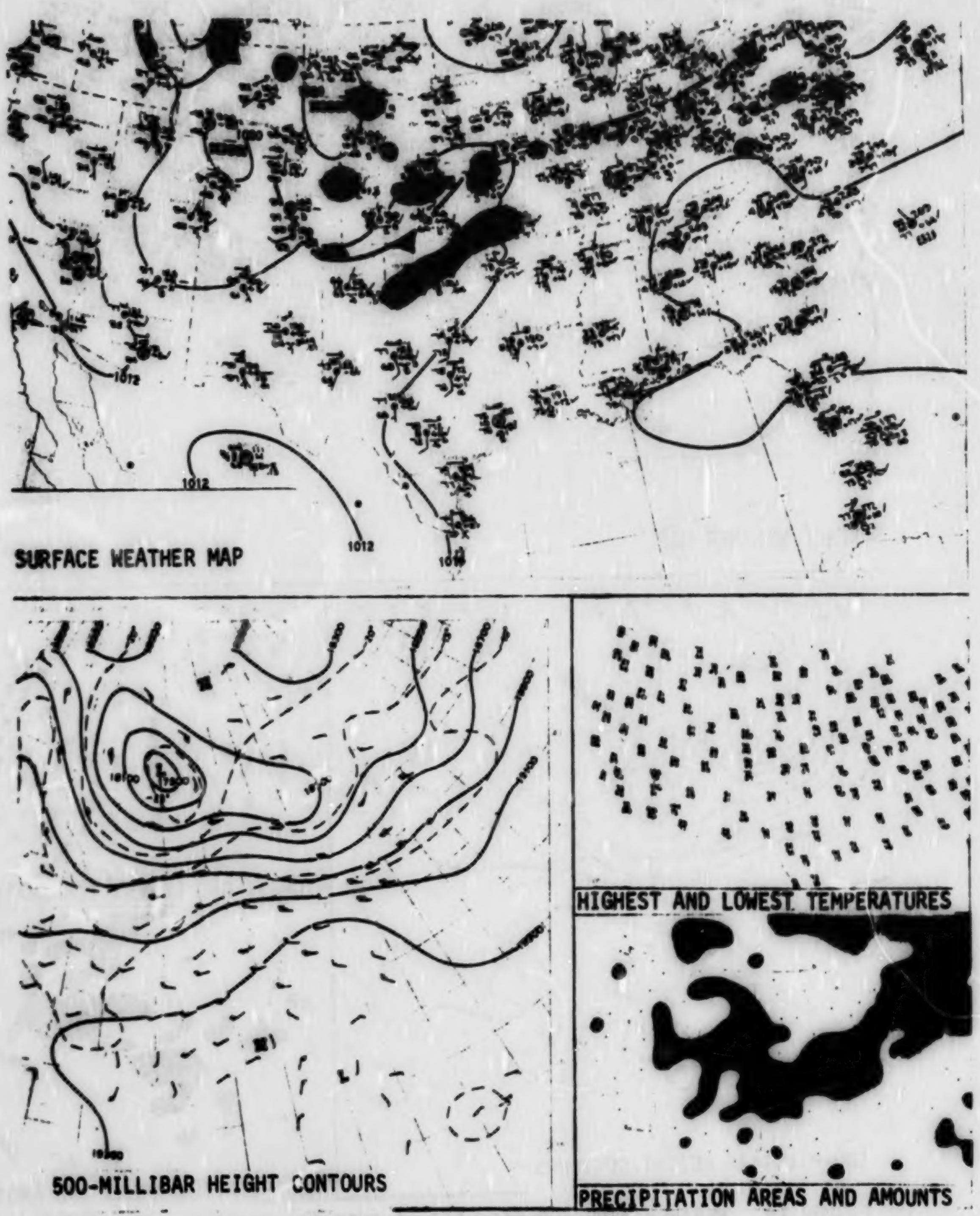
500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

HIGH
HIGH
LOW
1012
1016
1016
LOW
HIGH
L
H
H

FIGURE 24. WEATHER MAPS FOR 0600 CST, AUGUST 13, 1975


SURFACE WEATHER MAP

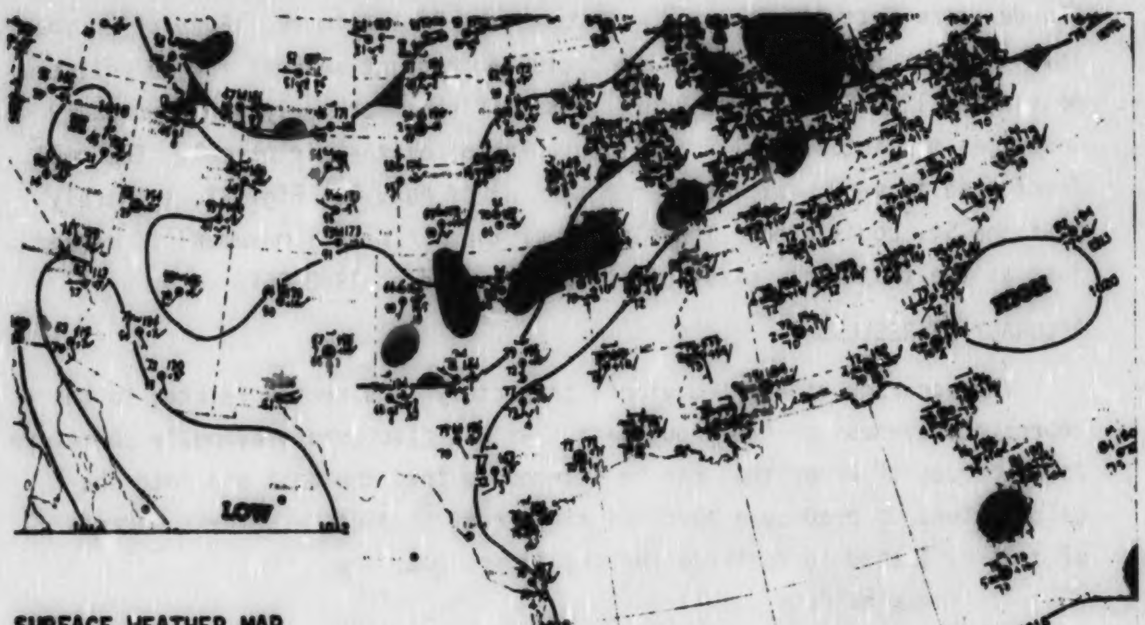
500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

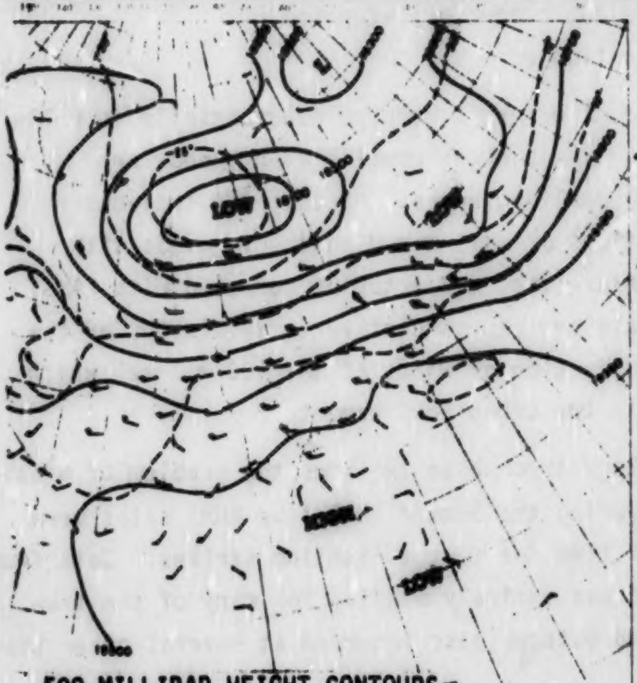
PRECIPITATION AREAS AND AMOUNTS

1012
1012
1012
1012
1016
1020
18700
17900
19200
18900

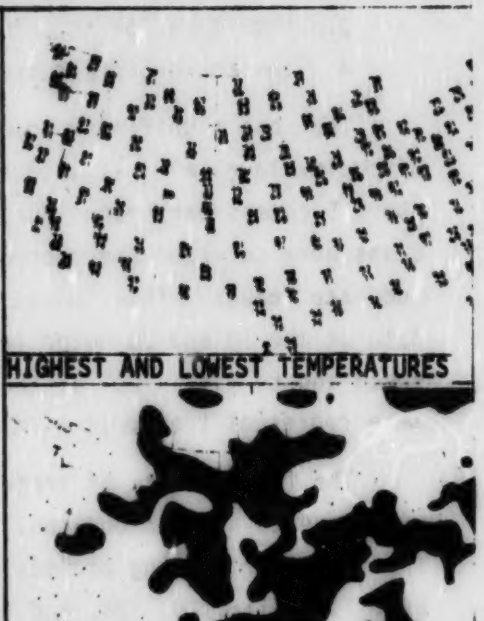
FIGURE 25. WEATHER MAPS FOR 0600 CST, AUGUST 14, 1975


LOW
HIGH
1016
1016

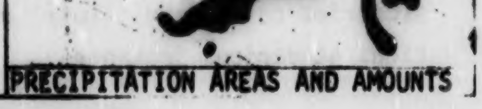
SURFACE WEATHER MAP


LOW
HIGH
HIGH
LOW
10000

500-MILLIBAR HEIGHT CONTOURS



HIGHEST AND LOWEST TEMPERATURES



PRECIPITATION AREAS AND AMOUNTS

FIGURE 26. WEATHER MAPS FOR 0600 CST, AUGUST 15, 1975

It is obvious from the detailed wind data that scattered, slow moving thunderstorm activity was moving through the RAMS network. Even after the initiation of northerly winds the pressure gradient weakens for an entire hour after 1330 CST. Three hours of significant northerly winds probably describes the actual cool front's entrainment of the air parcel. The cool front push is very weak and by the morning of Aug. 16, Fig. 27, is barely past the St. Louis area. The slowing of the air parcel movement is marked just as the trajectory exists the regional grid at 1900 CST.

ACCURACY OF RESULTS

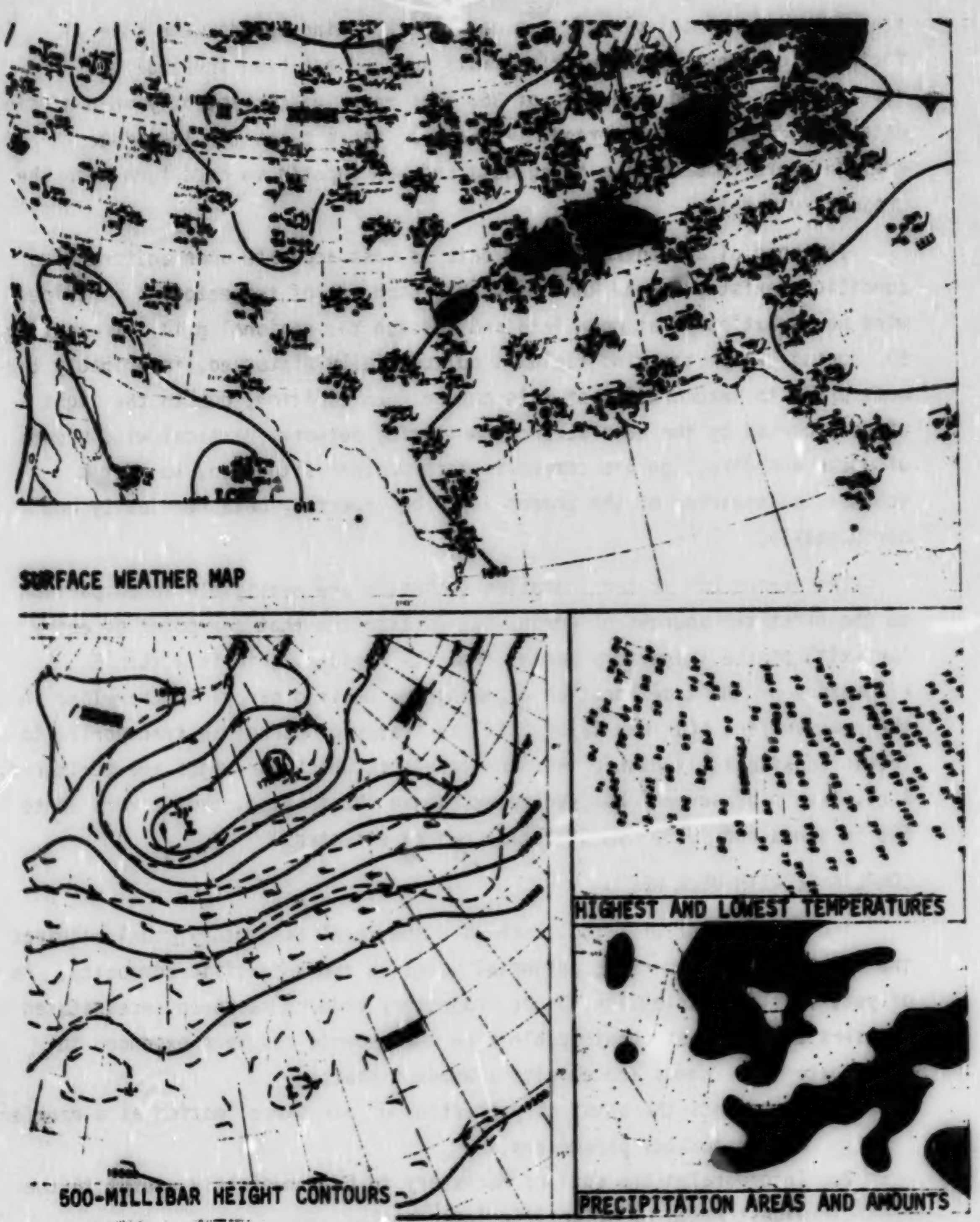
The accuracy of any individual trajectory is directly related to the representativeness of the input data. As was discussed previously there are four sources of error that can be introduced into the data and into the calculations to produce a spurious air parcel trajectory. These sources of errors, listed in their decreasing importance, are

1. the wind data
2. the spacial averaging of the wind field
3. the iteration technique for trajectory stepping
4. the round-off and truncation errors

The most significant source of error is reduced substantially in well-mixed low-level wind situations. These occur usually when speeds are above 5 meters per second during daylight hours. Most of the trajectory cases were selected under conditions of well-mixed southerly winds with moderate speeds. This should ensure that trajectories computed with RAMS data at the 10 and 30 meter levels are representative to within 20% of the speed and to within 20° of the direction of winds at the 100 m level which move represent transport winds in the urban environment.

The first source of trajectory error also includes the problem of missing winds due to station outages. During the Summer 1975 five RAMS sites were shut down for varying periods of time due to the lighting strikes. Data from RAMS 101, 111, 120, 124, and 125 was entirely missing for many of the trajectories calculated. Total wind outages also occurred at several other stations at various instances.

Two sources of wind data error were corrected manually before



SURFACE WEATHER MAP

500-MILLIBAR HEIGHT CONTOURS

HIGHEST AND LOWEST TEMPERATURES

PRECIPITATION AREAS AND AMOUNTS

FIGURE 27. WEATHER MAPS FOR 0600 CST, AUGUST 16, 1975

trajectories were calculated. In one case all wind speeds were several factors too high but were within limits and had not been invalidated. In several cases a wind direction of 360° was reported consistently when missing data should have been reported. In each of these cases the 15-minute averages were reduced to missing data and was inputed in card form into the trajectory model.

The spacial averaging of RAMS data is most accurate when uniform wind conditions exist over the RAMS network. Each set of trajectories contained wind perturbations that move into and through the regional grid. Trajectory 50, during which the wind field is substantially disturbed, is probably the most prone to inaccuracies of this nature. In addition, due to the light winds reported by the near-surface monitoring network, vertical wind shears of speed and direction are common in this weather situation, so that a substantial smearing of the tracer is to be expected, both vertically and horizontally.

The errors due to the iteration technique are negligible in comparison to the first two sources of error. It is expected that the point of entry (or exit) of the trajectory parcel from the regional grid is within 5 kilometers of the true location assuming the desired parcel is traveling in the near-surface boundary layer. If the tracer or parcel is transported to levels substantially higher than the levels at which the winds are monitored, i.e., levels of several hundred meters above the surface, then errors up to 50% in speed and 40-50° in direction can be expected.

COMPLIANCE WITH USER NEEDS

The development of a tool such as a low-level trajectory model requires the inputs from the various potential users in the scientific community. As of yet, little contribution to the trajectory product has been necessitated by users demands, but considerable time and expense has been expended to anticipate these needs and develop a product that:

1. Represents the physical properties of air parcel motion as a carrier of air quality parameters.
2. Incorporates the options necessary to be immediately useful to the widest range of scientific interests.

3. And can be accessed quickly for fast turn around to provide trajectory results in conjunction with the analysis of field measurements.

Both pictorial and tabular formats are provided so that immediate recognition of data results can be obtained. Various additional parameters, such as incremental speed and directions and accumulated trajectory path lengths are precalculated and are listed on the tabular data summary. This format can be changed to optimize the user needs.

Various map scales can be provided to conform to the scale and detail that the scientific investigator desires. For the RAMS network three scales, a 100 by 100 kilometer (regional scale), a 50 by 50 kilometer (metropolitan scale), and a 20 by 20 kilometer (urban scale), can be represented in the pictorial air parcel path display. Unlimited representations of other scales for other data networks can be manufactured with little added effort.

REFERENCES

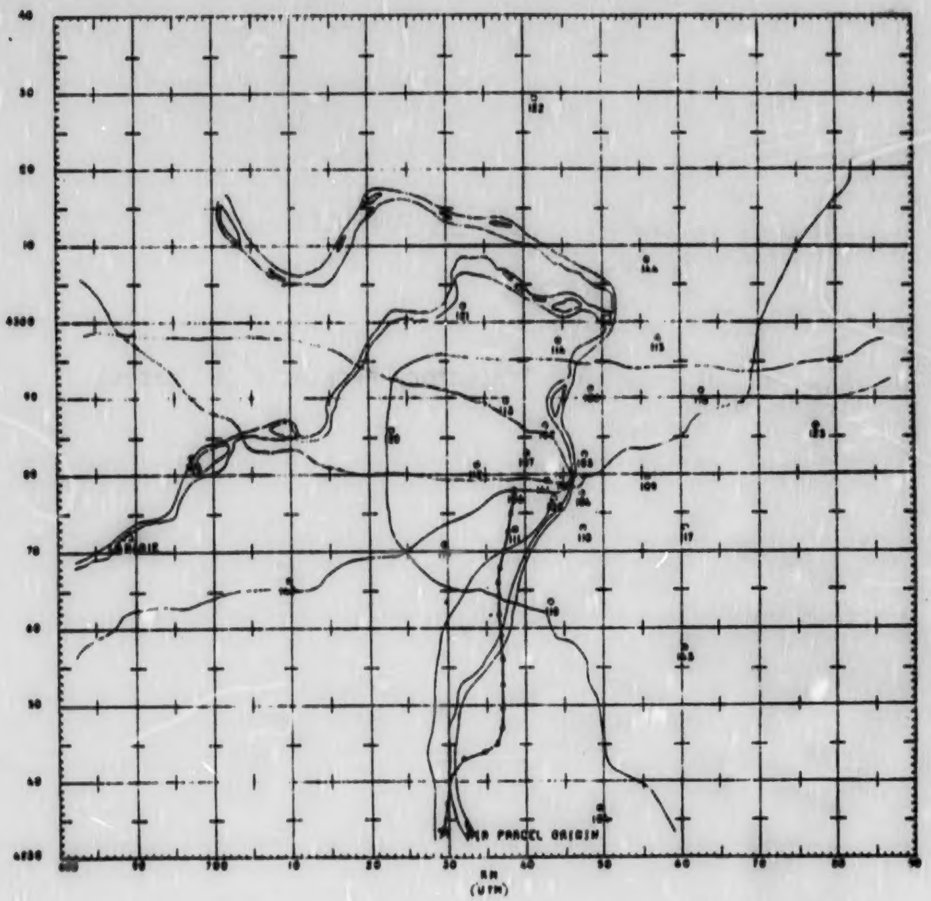
Danneyik, W.P. et. al. Analysis and Characterization of Heat-Island Induced Urban Circulation During the 1973 EPA Aerosol Characterization Study, St. Louis, Missouri. In: Proceedings of the Fifth Conference on Forecasting and Analysis, American Meteorological Society. St. Louis, Missouri, March 1974. 6pp.

Karl, T.R. Summertime Surface Wind Fields in St. Louis. In: Proceedings of the Third Synopsium on Atmospheric Turbulence Diffusion and Air Quality, American Meteorological Society. Raleigh, North Carolina, October 1976. pp 107-113.

Lamb, B.K. et. al. Tracer Studies for Characterizing the Transport and Dispersion of Plumes Emitted at Ground and at Elevated Levels. In: Proceedings of a Regional Air Pollution Study Conference Summarizing the St. Louis, Missouri Summer 1975 Summer Exercises, Environmental Protection Agency. Research Triangle Park, North Carolina, October, 1975. pp 83-88.

APPENDIX

A: Trajectory Printouts (50 cases)


40
30
20
10
4300
90
80
70
60
50
40
4230
600
90
700
10
20
30
40
50
60
70
80
90
KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #1
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 106

STARTING 1530 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 17 JUL 75  1530 CST     END TIME: 17 JUL 75  2000 CST
    INITIAL COORDINATES: 4277566N. 738660E.     LOCATION DESCRIPTOR: RAMS STATION NO. 106
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 18

                                                                                           ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT                PATH      AZIMUTH          SPEED
STEP   TIME        LOCATION             RADIAL   AZIMUTH      SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2000 CST   4277566N.  738660E.        0 M      0 DEG     0 M/SEC          0 M       0 DEG        0 M/SEC
  1    1945 CST   4279072N.  738216E.   2533.0 M  190.1 DEG  2.81 M/SEC     2533.0 M   190.1 DEG     2.81 M/SEC
  2    1930 CST   4272706N.  737870E.   2390.7 M  188.3 DEG  2.66 M/SEC     4923.7 M   189.2 DEG     2.74 M/SEC
  3    1915 CST   4270207N.  737289E.   2566.0 M  193.1 DEG  2.85 M/SEC     7489.7 M   190.6 DEG     2.77 M/SEC
  4    1900 CST   4267990N.  736731E.   2286.2 M  194.1 DEG  2.54 M/SEC     9775.9 M   191.4 DEG     2.72 M/SEC
  5    1845 CST   4266141N.  736542E.   1858.3 M  185.8 DEG  2.06 M/SEC    11634.2 M   190.5 DEG     2.59 M/SEC
  6    1830 CST   4264321N.  736611E.   1821.7 M  177.8 DEG  2.02 M/SEC    13455.9 M   188.8 DEG     2.49 M/SEC
  7    1815 CST   4261998N.  736681E.   2324.0 M  178.3 DEG  2.58 M/SEC    15779.9 M   187.2 DEG     2.50 M/SEC
  8    1800 CST   4259285N.  736923E.   2723.5 M  174.9 DEG  3.03 M/SEC    18503.4 M   185.4 DEG     2.57 M/SEC
  9    1745 CST   4256195N.  737071E.   3093.7 M  177.3 DEG  3.44 M/SEC    21597.2 M   184.3 DEG     2.67 M/SEC
 10    1730 CST   4252880N.  737085E.   3314.4 M  179.8 DEG  3.68 M/SEC    24911.6 M   183.7 DEG     2.77 M/SEC
 11    1715 CST   4249783N.  737020E.   3098.2 M  181.2 DEG  3.44 M/SEC    28009.7 M   183.4 DEG     2.83 M/SEC
 12    1700 CST   4247248N.  736965E.   2535.4 M  181.3 DEG  2.82 M/SEC    30545.1 M   183.2 DEG     2.83 M/SEC
 13    1645 CST   4245230N.  736275E.   2132.8 M  198.9 DEG  2.37 M/SEC    32678.3 M   184.2 DEG     2.79 M/SEC
 14    1630 CST   4244135N.  734643E.   1965.5 M  236.2 DEG  2.18 M/SEC    34643.5 M   186.9 DEG     2.75 M/SEC
 15    1615 CST   4243252N.  731560E.   2823.8 M  251.8 DEG  3.14 M/SEC    37467.2 M   191.0 DEG     2.70 M/SEC
 16    1600 CST   4240894N.  730300E.   2883.7 M  215.2 DEG  3.20 M/SEC    40351.3 M   192.8 DEG     2.80 M/SEC
 17    1545 CST   4237333N.  729872E.   3587.3 M  186.9 DEG  3.99 M/SEC    43938.3 M   192.3 DEG     2.87 M/SEC
 18    1530 CST   4233766N.  729291E.   3613.5 M  189.2 DEG  4.02 M/SEC    47551.8 M   192.1 DEG     2.94 M/SEC
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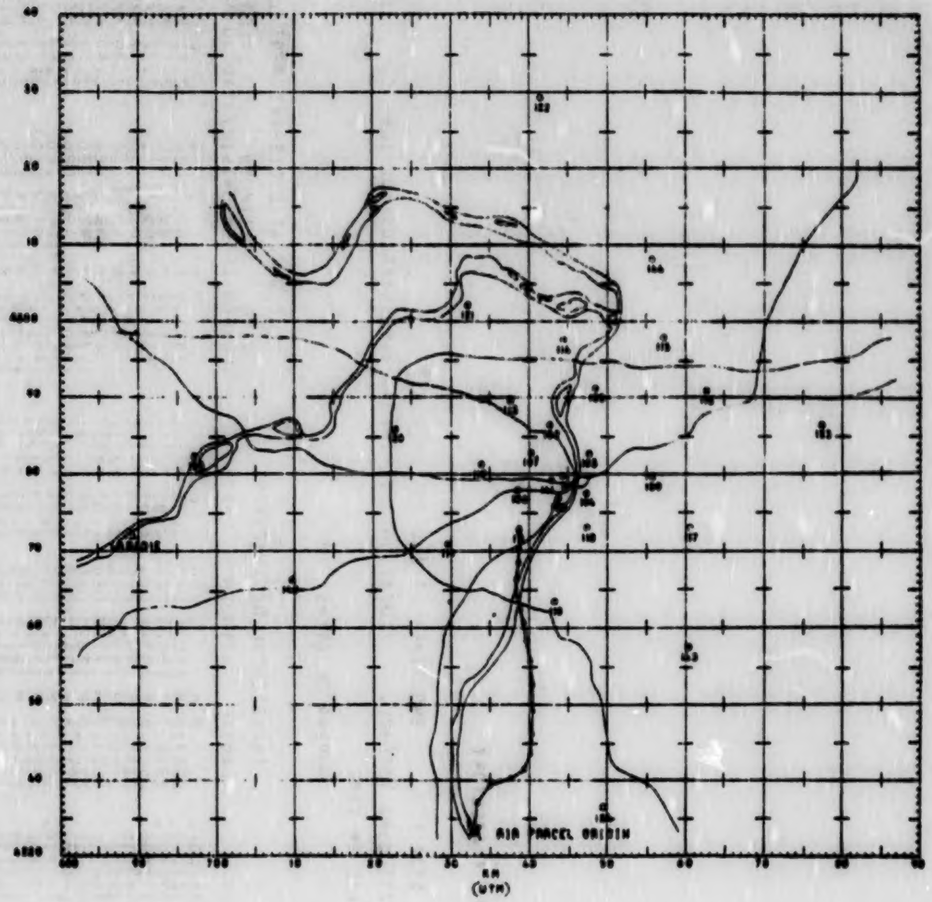


RAMS NEAR-SFC
TRAJECTORY #2
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 111

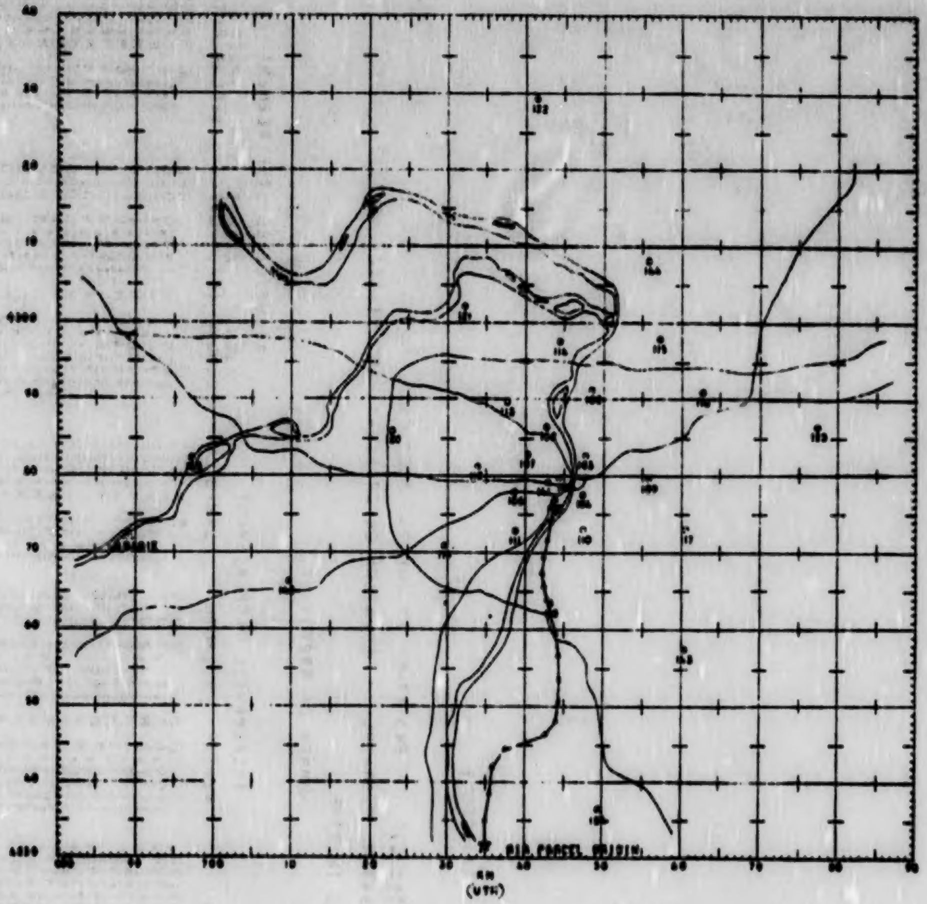
STARTING 1545 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 17 JUL 75  1545 CST     END TIME: 17 JUL 75  2000 CST
    INITIAL COORDINATES: 4272479N. 738812E.     LOCATION DESCRIPTOR: RAMS STATION NO. 111
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN         NUMBER OF STEPS: 17

                                                                                  ACCUMULATED DISPLACEMENT
                                        INCREMENTAL DISPLACEMENT               PATH       AZIMUTH        SPEED
STEP   TIME         LOCATION          RADIAL    AZIMUTH      SPEED          LENGTH (FROM ORIGIN) (ALONG PATH)

  0    2000 CST  4272479N. 738812E.        0 M       0 DEG      0 M/SEC          0 M       0 DEG       0 M/SEC
  1    1945 CST  4270669N. 738793E.   1809.6 M   180.9 DEG   2.01 M/SEC     1809.6 M   180.9 DEG    2.01 M/SEC
  2    1930 CST  4268695N. 738672E.   1977.3 M   183.2 DEG   2.20 M/SEC     3786.9 M   182.1 DEG    2.10 M/SEC
  3    1915 CST  4266564N. 738398E.   2149.9 M   187.6 DEG   2.39 M/SEC     5936.8 M   184.1 DEG    2.20 M/SEC
  4    1900 CST  4264566N. 738407E.   1997.7 M   179.5 DEG   2.22 M/SEC     7934.5 M   182.9 DEG    2.20 M/SEC
  5    1845 CST  4262708N. 738864E.   1913.7 M   166.2 DEG   2.13 M/SEC     9848.2 M   179.7 DEG    2.19 M/SEC
  6    1830 CST  4260854N. 739334E.   1912.8 M   165.8 DEG   2.13 M/SEC    11761.1 M   177.4 DEG    2.18 M/SEC
  7    1815 CST  4258669N. 739655E.   2208.2 M   171.6 DEG   2.45 M/SEC    13969.3 M   176.5 DEG    2.22 M/SEC
  8    1800 CST  4256017N. 740131E.   2694.1 M   169.8 DEG   2.99 M/SEC    16663.3 M   175.4 DEG    2.31 M/SEC
  9    1745 CST  4252985N. 740439E.   3147.1 M   174.4 DEG   3.50 M/SEC    19810.5 M   175.3 DEG    2.45 M/SEC
 10    1730 CST  4249550N. 740429E.   3335.4 M   180.2 DEG   3.71 M/SEC    23145.9 M   176.0 DEG    2.57 M/SEC
 11    1715 CST  4246488N. 740354E.   3063.1 M   191.4 DEG   3.40 M/SEC    26209.0 M   176.8 DEG    2.65 M/SEC
 12    1700 CST  4243872N. 740042E.   2633.9 M   186.8 DEG   2.93 M/SEC    28843.0 M   177.5 DEG    2.67 M/SEC
 13    1645 CST  4241793N. 739255E.   2222.8 M   200.7 DEG   2.47 M/SEC    31065.7 M   179.2 DEG    2.66 M/SEC
 14    1630 CST  4240701N. 737620E.   1966.5 M   236.3 DEG   2.19 M/SEC    33032.3 M   182.1 DEG    2.62 M/SEC
 15    1615 CST  4239809N. 734946E.   2818.5 M   251.5 DEG   3.13 M/SEC    35850.8 M   186.7 DEG    2.66 M/SEC
 16    1600 CST  4237449N. 733308E.   2872.8 M   214.8 DEG   3.19 M/SEC    38723.6 M   188.9 DEG    2.69 M/SEC
 17    1545 CST  4233906N. 732893E.   3567.5 M   186.7 DEG   3.96 M/SEC    42291.1 M   188.7 DEG    2.76 M/SEC
```


AIR PARCEL ORIGIN
KM
(UTM)
4300
700
10
20
30
40
50
60
70
80
90

RAMS NEAR-SFC
TRAJECTORY #3
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 105

STARTING 1515 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 17 JUL 75  1515 CST      END TIME: 17 JUL 75  2000 CST
     INITIAL COORDINATES: 4276453N. 743706E.     LOCATION DESCRIPTOR: RAMS STATION NO. 105
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 19

                                                                                ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT           PATH       AZIMUTH         SPEED
STEP    TIME        LOCATION            RADIAL    AZIMUTH      SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2000 CST   4276453N.  743706E.        0 M      0 DEG      0 M/SEC         0 M      0 DEG      0 M/SEC
  1    1945 CST   4274118N.  743279E.   2373.4 M  190.3 DEG   2.64 M/SEC    2373.4 M  190.3 DEG   2.64 M/SEC
  2    1930 CST   4271833N.  742831E.   2327.8 M  191.1 DEG   2.59 M/SEC    4701.2 M  190.7 DEG   2.61 M/SEC
  3    1915 CST   4269563N.  742224E.   2326.4 M  192.6 DEG   2.58 M/SEC    7027.7 M  191.3 DEG   2.60 M/SEC
  4    1900 CST   4267540N.  742130E.   2032.4 M  185.5 DEG   2.26 M/SEC    9060.1 M  190.0 DEG   2.52 M/SEC
  5    1845 CST   4265837N.  742370E.   1720.0 M  172.0 DEG   1.91 M/SEC   10780.1 M  187.2 DEG   2.40 M/SEC
  6    1830 CST   4264157N.  742737E.   1719.0 M  167.7 DEG   1.91 M/SEC   12499.1 M  184.5 DEG   2.31 M/SEC
  7    1815 CST   4262181N.  743203E.   2030.7 M  166.7 DEG   2.26 M/SEC   14529.8 M  182.0 DEG   2.31 M/SEC
  8    1800 CST   4259770N.  743837E.   2490.0 M  165.5 DEG   2.77 M/SEC   17019.8 M  179.6 DEG   2.36 M/SEC
  9    1745 CST   4256884N.  744200E.   2911.3 M  172.5 DEG   3.23 M/SEC   19931.2 M  178.5 DEG   2.46 M/SEC
 10    1730 CST   4253793N.  744230E.   3090.5 M  179.6 DEG   3.43 M/SEC   23021.7 M  178.7 DEG   2.56 M/SEC
 11    1715 CST   4250901N.  744179E.   2893.1 M  191.0 DEG   3.21 M/SEC   25914.8 M  178.9 DEG   2.62 M/SEC
 12    1700 CST   4248395N.  743814E.   2531.9 M  188.3 DEG   2.81 M/SEC   28446.8 M  179.8 DEG   2.63 M/SEC
 13    1645 CST   4246642N.  742405E.   2249.1 M  218.9 DEG   2.50 M/SEC   30695.9 M  182.5 DEG   2.62 M/SEC
 14    1630 CST   4245620N.  740032E.   2583.8 M  246.7 DEG   2.87 M/SEC   33279.4 M  186.8 DEG   2.64 M/SEC
 15    1615 CST   4244721N.  737363E.   2816.3 M  251.4 DEG   3.13 M/SEC   36095.7 M  191.3 DEG   2.67 M/SEC
 16    1600 CST   4242365N.  735750E.   2855.6 M  214.4 DEG   3.17 M/SEC   38951.2 M  193.1 DEG   2.70 M/SEC
 17    1545 CST   4238851N.  735355E.   3535.8 M  186.4 DEG   3.93 M/SEC   42487.0 M  192.5 DEG   2.78 M/SEC
 18    1530 CST   4235341N.  734779E.   3556.7 M  189.3 DEG   3.95 M/SEC   46043.8 M  192.3 DEG   2.84 M/SEC
 19    1515 CST   4232104N.  734729E.   3237.4 M  190.9 DEG   3.60 M/SEC   49281.2 M  191.4 DEG   2.88 M/SEC
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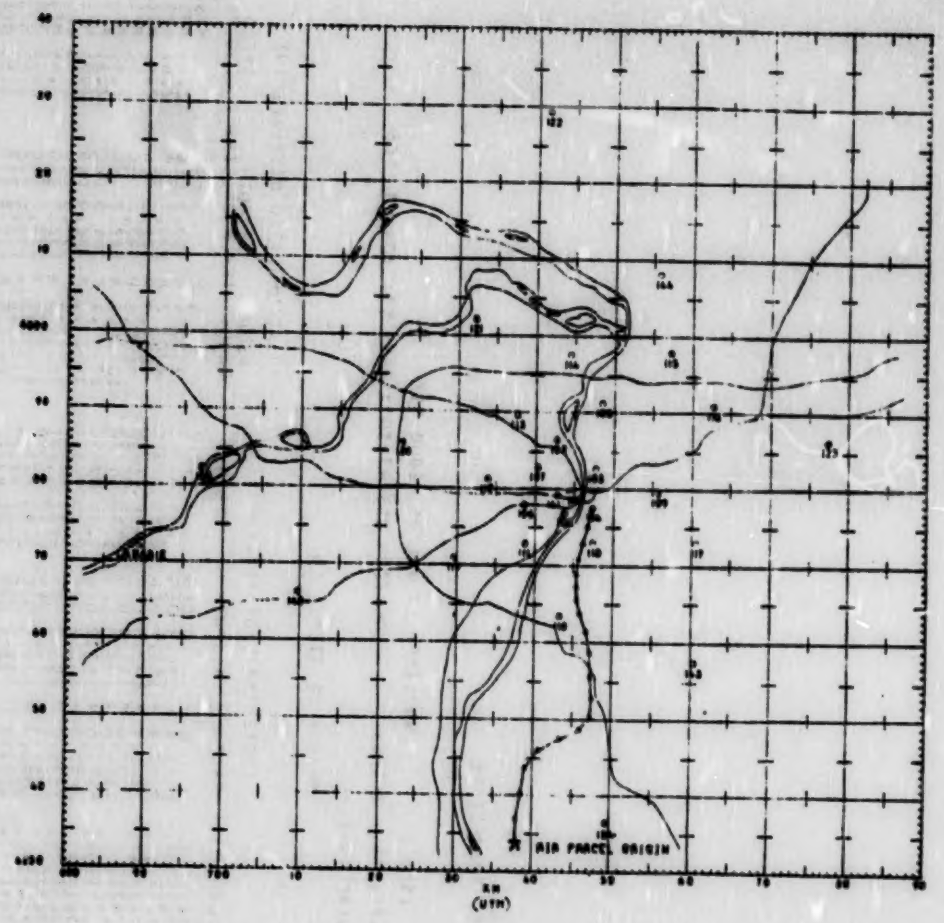
AIR PARCEL ORIGIN
KM
(UTM)
700
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20
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60
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80
90

RAMS NEAR-SFC
TRAJECTORY #4
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 104

STARTING 1515 CDT 17 JUL 75
ARRIVING 2000 CDT 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 17 JUL 75  1515 CST     END TIME: 17 JUL 75  2000 CST

    INITIAL COORDINATES: 4277304N. 747312E.     LOCATION DESCRIPTOR: RAMS STATION NO. 104

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 19

                                                                                ACCUMULATED DISPLACEMENT
                                          INCREMENTAL DISPLACEMENT
                                                                           PATH      AZIMUTH        SPEED
STEP   TIME         LOCATION           RADIAL    AZIMUTH      SPEED        LENGTH (FROM ORIGIN) (ALONG PATH)

  0   2000 CST  4277304N. 747312E.       0 M       0 DEG      0 M/SEC          0 M     0 DEG       0 M/SEC
  1   1945 CST  4275138N. 746863E.  2213.6 M  191.7 DEG   2.46 M/SEC     2213.6 M 191.7 DEG    2.46 M/SEC
  2   1930 CST  4272999N. 746291E.  2212.6 M  195.0 DEG   2.46 M/SEC     4426.3 M 193.3 DEG    2.46 M/SEC
  3   1915 CST  4270896N. 745744E.  2172.3 M  194.6 DEG   2.41 M/SEC     6598.6 M 193.7 DEG    2.44 M/SEC
  4   1900 CST  4269019N. 745504E.  1992.9 M  187.3 DEG   2.10 M/SEC     8491.4 M 192.3 DEG    2.36 M/SEC
  5   1845 CST  4267352N. 745487E.  1666.8 M  180.6 DEG   1.85 M/SEC    10158.2 M 190.4 DEG    2.26 M/SEC
  6   1830 CST  4265679N. 745547E.  1673.7 M  177.9 DEG   1.86 M/SEC    11831.9 M 188.6 DEG    2.19 M/SEC
  7   1815 CST  4263932N. 745964E.  1894.1 M  167.3 DEG   2.10 M/SEC    13726.0 M 185.7 DEG    2.18 M/SEC
  8   1800 CST  4261553N. 746725E.  2405.3 M  161.3 DEG   2.67 M/SEC    16131.3 M 182.1 DEG    2.24 M/SEC
  9   1745 CST  4258752N. 747251E.  2848.9 M  169.6 DEG   3.17 M/SEC    18980.2 M 180.2 DEG    2.34 M/SEC
 10   1730 CST  4255752N. 747370E.  3001.8 M  177.7 DEG   3.34 M/SEC    21982.0 M 179.8 DEG    2.44 M/SEC
 11   1715 CST  4252926N. 747503E.  2829.9 M  177.3 DEG   3.14 M/SEC    24811.9 M 179.5 DEG    2.51 M/SEC
 12   1700 CST  4250540N. 747357E.  2390.7 M  183.5 DEG   2.66 M/SEC    27201.7 M 179.9 DEG    2.52 M/SEC
 13   1645 CST  4248867N. 745953E.  2158.5 M  219.2 DEG   2.40 M/SEC    29360.1 M 182.7 DEG    2.51 M/SEC
 14   1630 CST  4247663N. 743456E.  2808.8 M  244.6 DEG   3.12 M/SEC    32168.9 M 187.4 DEG    2.55 M/SEC
 15   1615 CST  4246206N. 740813E.  3019.3 M  241.1 DEG   3.35 M/SEC    35187.2 M 191.8 DEG    2.61 M/SEC
 16   1600 CST  4243850N. 739111E.  2905.6 M  215.9 DEG   3.23 M/SEC    38092.8 M 193.8 DEG    2.65 M/SEC
 17   1545 CST  4240547N. 738600E.  3343.1 M  198.8 DEG   3.71 M/SEC    41435.9 M 193.3 DEG    2.71 M/SEC
 18   1530 CST  4237253N. 738011E.  3345.8 M  190.1 DEG   3.72 M/SEC    44781.8 M 193.1 DEG    2.76 M/SEC
 19   1515 CST  4234032N. 737961E.  3221.6 M  190.9 DEG   3.58 M/SEC    48003.4 M 192.2 DEG    2.81 M/SEC
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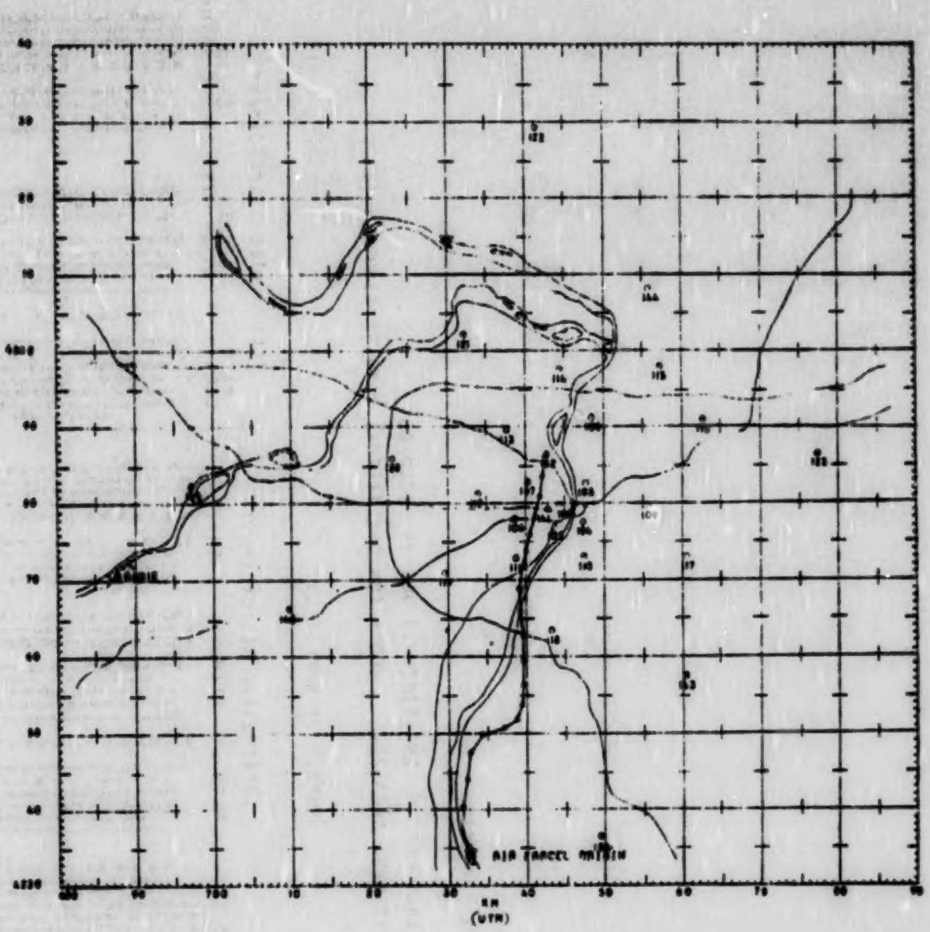
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #5
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 102

STARTING 1500 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 17 JUL 75  1500 CST     END TIME: 17 JUL 75  2000 CST
    INITIAL COORDINATES: 4286045N. 742518E.     LOCATION DESCRIPTOR: RAMS STATION NO. 102
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN         NUMBER OF STEPS: 20

                                                                                 ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT           PATH        AZIMUTH         SPEED
STEP   TIME         LOCATION           RADIAL    AZIMUTH     SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2000 CST  4286045N. 742518E.        0 M       0 DEG     0 M/SEC          0 M      0 DEG        0 M/SEC
  1    1945 CST  4283553N. 742296E.   2505.6 M   186.0 DEG  2.79 M/SEC     2505.6 M  186.0 DEG     2.78 M/SEC
  2    1930 CST  4280916N. 741861E.   2666.5 M   188.5 DEG  2.96 M/SEC     5172.1 M  187.3 DEG     2.87 M/SEC
  3    1915 CST  4279318N. 741232E.   2672.4 M   193.6 DEG  2.97 M/SEC     7844.5 M  189.4 DEG     2.91 M/SEC
  4    1900 CST  4275919N. 740601E.   2481.0 M   194.7 DEG  2.76 M/SEC    10325.5 M  190.7 DEG     2.87 M/SEC
  5    1845 CST  4273909N. 740085E.   2172.3 M   193.8 DEG  2.41 M/SEC    12497.7 M  191.2 DEG     2.78 M/SEC
  6    1830 CST  4271655N. 739959E.   2213.3 M   193.7 DEG  2.46 M/SEC    14711.0 M  191.6 DEG     2.72 M/SEC
  7    1815 CST  4269920N. 739174E.   2766.1 M   198.0 DEG  3.07 M/SEC    17477.1 M  191.0 DEG     2.77 M/SEC
  8    1800 CST  4265377N. 739339E.   2947.2 M   176.8 DEG  3.27 M/SEC    20424.3 M  189.0 DEG     2.84 M/SEC
  9    1745 CST  4262972N. 739628E.   3119.5 M   174.7 DEG  3.47 M/SEC    23542.8 M  187.1 DEG     2.91 M/SEC
 10    1730 CST  4259536N. 739649E.   3335.9 M   179.6 DEG  3.71 M/SEC    26878.7 M  186.2 DEG     2.99 M/SEC
 11    1715 CST  4256478N. 739654E.   3058.4 M   179.9 DEG  3.40 M/SEC    29937.1 M  185.5 DEG     3.02 M/SEC
 12    1700 CST  4253975N. 739490E.   2508.9 M   184.0 DEG  2.79 M/SEC    32445.9 M  185.4 DEG     3.00 M/SEC
 13    1645 CST  4252204N. 738761E.   2097.9 M   200.0 DEG  2.33 M/SEC    34543.3 M  186.3 DEG     2.95 M/SEC
 14    1630 CST  4250915N. 737125E.   1965.6 M   236.4 DEG  2.18 M/SEC    36509.5 M  188.7 DEG     2.90 M/SEC
 15    1615 CST  4250028N. 734444E.   2824.0 M   251.7 DEG  3.14 M/SEC    39333.4 M  192.6 DEG     2.91 M/SEC
 16    1600 CST  4247676N. 732804E.   2867.6 M   214.9 DEG  3.19 M/SEC    42201.0 M  194.2 DEG     2.93 M/SEC
 17    1545 CST  4244143N. 732394E.   3555.6 M   186.6 DEG  3.95 M/SEC    45757.6 M  193.6 DEG     2.99 M/SEC
 18    1530 CST  4240611N. 731817E.   3578.9 M   189.3 DEG  3.98 M/SEC    49336.4 M  193.3 DEG     3.05 M/SEC
 19    1515 CST  4237366N. 731768E.   3245.4 M   190.9 DEG  3.61 M/SEC    52581.8 M  192.5 DEG     3.07 M/SEC
 20    1500 CST  4234775N. 732684E.   2749.3 M   160.5 DEG  3.05 M/SEC    55330.1 M  193.9 DEG     3.07 M/SEC
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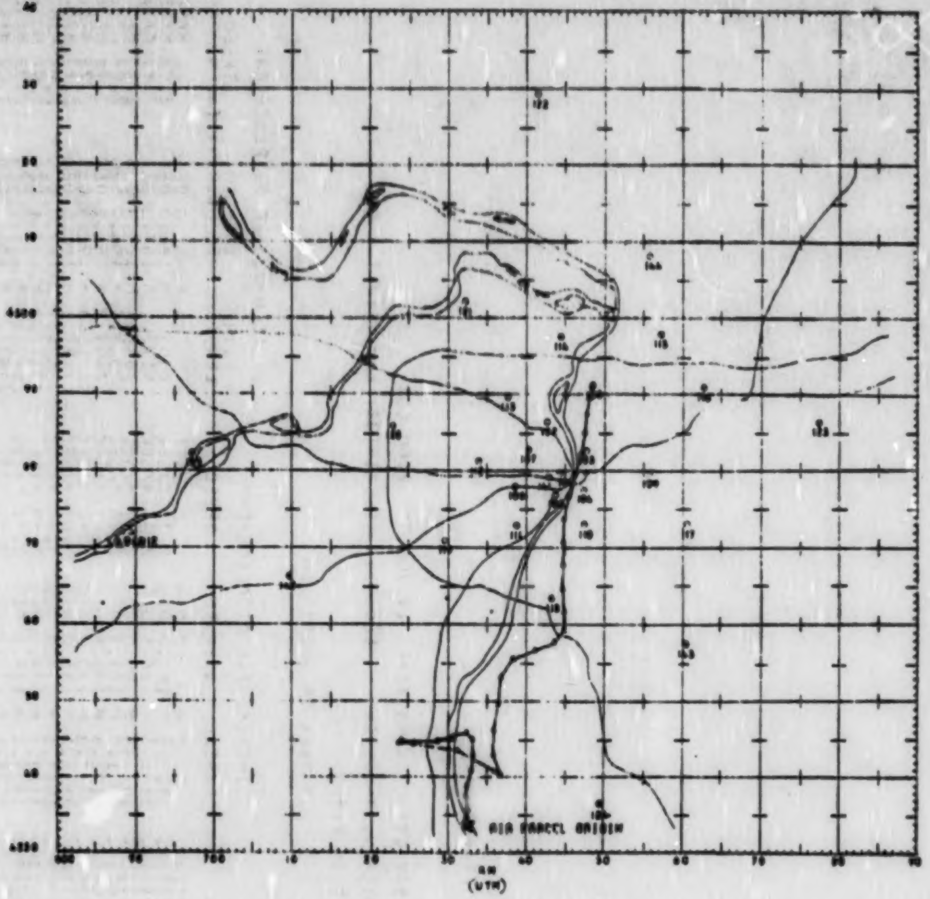
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KM
(UTM)
AIR PARCEL ORIGIN
122
164
115
110
113
123
108
117
111
AIRPORT

RAMS NEAR-SFC
TRAJECTORY #6
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 108

STARTING 1100 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 17 JUL 75  1100 CST      END TIME: 17 JUL 75  2000 CST
    INITIAL COORDINATES: 4291102N. 748407E.      LOCATION DESCRIPTOR: RAPS STATION NO. 108
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 36

                                                                                      ACCUMULATED DISPLACEMENT
                                               INCREMENTAL DISPLACEMENT            PATH         AZIMUTH          SPEED
STEP   TIME          LOCATION             RADIAL     AZIMUTH       SPEED          LENGTH    (FROM ORIGIN)   (ALONG PATH)

  0    2000 CST   4291102N.  748407E.        0 M        0 DEG       0 M/SEC           0 M        0 DEG          0 M/SEC
  1    1945 CST   4289589N.  748158E.   1533.0 M    189.3 DEG    1.70 M/SEC      1533.0 M    189.3 DEG       1.70 M/SEC
  2    1930 CST   4287506N.  747863E.   2104.0 M    188.1 DEG    2.34 M/SEC      3637.1 M    188.6 DEG       2.02 M/SEC
  3    1915 CST   4285103N.  747577E.   2419.2 M    186.8 DEG    2.69 M/SEC      6056.3 M    187.9 DEG       2.24 M/SEC
  4    1900 CST   4282328N.  747081E.   2818.9 M    190.1 DEG    3.13 M/SEC      8875.2 M    189.6 DEG       2.47 M/SEC
  5    1845 CST   4279507N.  746331E.   2919.7 M    194.9 DEG    3.24 M/SEC     11794.9 M    190.1 DEG       2.62 M/SEC
  6    1830 CST   4276831N.  745462E.   2813.5 M    198.0 DEG    3.13 M/SEC     14608.4 M    191.7 DEG       2.71 M/SEC
  7    1815 CST   4273904N.  744861E.   3085.8 M    191.2 DEG    3.43 M/SEC     17694.2 M    191.6 DEG       2.81 M/SEC
  8    1800 CST   4270822N.  744743E.   2984.2 M    182.3 DEG    3.32 M/SEC     20678.3 M    190.2 DEG       2.87 M/SEC
  9    1745 CST   4267899N.  744735E.   2923.4 M    180.1 DEG    3.25 M/SEC     23601.7 M    189.0 DEG       2.91 M/SEC
 10    1730 CST   4264823N.  744655E.   3077.3 M    181.5 DEG    3.42 M/SEC     26679.0 M    188.1 DEG       2.96 M/SEC
 11    1715 CST   4261914N.  744930E.   2914.2 M    176.6 DEG    3.24 M/SEC     29593.2 M    187.0 DEG       2.99 M/SEC
 12    1700 CST   4259538N.  744818E.   2375.7 M    180.3 DEG    2.64 M/SEC     31969.0 M    186.5 DEG       2.96 M/SEC
 13    1645 CST   4257907N.  743550E.   2066.1 M    217.9 DEG    2.30 M/SEC     34035.1 M    188.3 DEG       2.91 M/SEC
 14    1630 CST   4256974N.  741167E.   2596.6 M    246.6 DEG    2.89 M/SEC     36631.7 M    191.9 DEG       2.91 M/SEC
 15    1615 CST   4255751N.  738297E.   3082.6 M    248.6 DEG    3.43 M/SEC     39714.3 M    196.0 DEG       2.94 M/SEC
 16    1600 CST   4253404N.  736743E.   2814.7 M    213.5 DEG    3.13 M/SEC     42528.9 M    197.2 DEG       2.95 M/SEC
 17    1545 CST   4249959N.  735956E.   3462.3 M    195.5 DEG    3.85 M/SEC     45991.3 M    196.3 DEG       3.01 M/SEC
 18    1530 CST   4246527N.  735826E.   3479.6 M    189.4 DEG    3.87 M/SEC     49469.9 M    195.8 DEG       3.05 M/SEC
 19    1515 CST   4243318N.  735775E.   3209.6 M    180.9 DEG    3.57 M/SEC     52679.5 M    194.9 DEG       3.08 M/SEC
 20    1500 CST   4240703N.  736662E.   2761.8 M    161.3 DEG    3.07 M/SEC     55441.3 M    193.1 DEG       3.08 M/SEC
 21    1445 CST   4241153N.  735866E.    914.6 M    299.5 DEG    1.02 M/SEC     56355.9 M    194.1 DEG       2.98 M/SEC
 22    1430 CST   4243777N.  731231E.   5325.8 M    299.5 DEG    5.92 M/SEC     61681.7 M    199.9 DEG       3.12 M/SEC
 23    1415 CST   4244640N.  725648E.   5649.0 M    279.8 DEG    6.28 M/SEC     67330.7 M    206.1 DEG       3.25 M/SEC
 24    1400 CST   4244605N.  723672E.   1983.8 M    274.8 DEG    2.20 M/SEC     69314.4 M    208.1 DEG       3.21 M/SEC
 25    1345 CST   4245217N.  724099E.    593.4 M     46.0 DEG    0.66 M/SEC     69907.8 M    207.9 DEG       3.11 M/SEC
 26    1330 CST   4244979N.  725719E.   1635.0 M     98.4 DEG    1.82 M/SEC     71545.7 M    206.2 DEG       3.06 M/SEC
 27    1315 CST   4245059N.  728665E.   2947.5 M     88.4 DEG    3.27 M/SEC     74493.2 M    203.2 DEG       3.07 M/SEC
 28    1300 CST   4245681N.  730668E.   2096.9 M     72.8 DEG    2.33 M/SEC     76590.0 M    201.3 DEG       3.04 M/SEC
 29    1245 CST   4246153N.  732375E.   1770.9 M     74.5 DEG    1.97 M/SEC     78360.8 M    199.6 DEG       3.00 M/SEC
 30    1230 CST   4245288N.  733160E.   1168.8 M    137.8 DEG    1.30 M/SEC     79529.6 M    198.4 DEG       2.95 M/SEC
 31    1215 CST   4243360N.  733144E.   1927.9 M    180.5 DEG    2.14 M/SEC     81457.4 M    197.7 DEG       2.92 M/SEC
 32    1200 CST   4241200N.  732936E.   2169.8 M    185.5 DEG    2.41 M/SEC     83627.3 M    197.2 DEG       2.90 M/SEC
 33    1145 CST   4239200N.  732356E.   2082.7 M    196.2 DEG    2.31 M/SEC     85709.9 M    197.2 DEG       2.89 M/SEC
 34    1130 CST   4237839N.  732246E.   1365.2 M    184.6 DEG    1.52 M/SEC     87075.1 M    196.9 DEG       2.85 M/SEC
 35    1115 CST   4236017N.  732473E.   1835.7 M    172.9 DEG    2.04 M/SEC     88910.8 M    196.1 DEG       2.82 M/SEC
 36    1100 CST   4234154N.  732435E.   1863.6 M    181.2 DEG    2.07 M/SEC     90774.3 M    195.7 DEG       2.80 M/SEC
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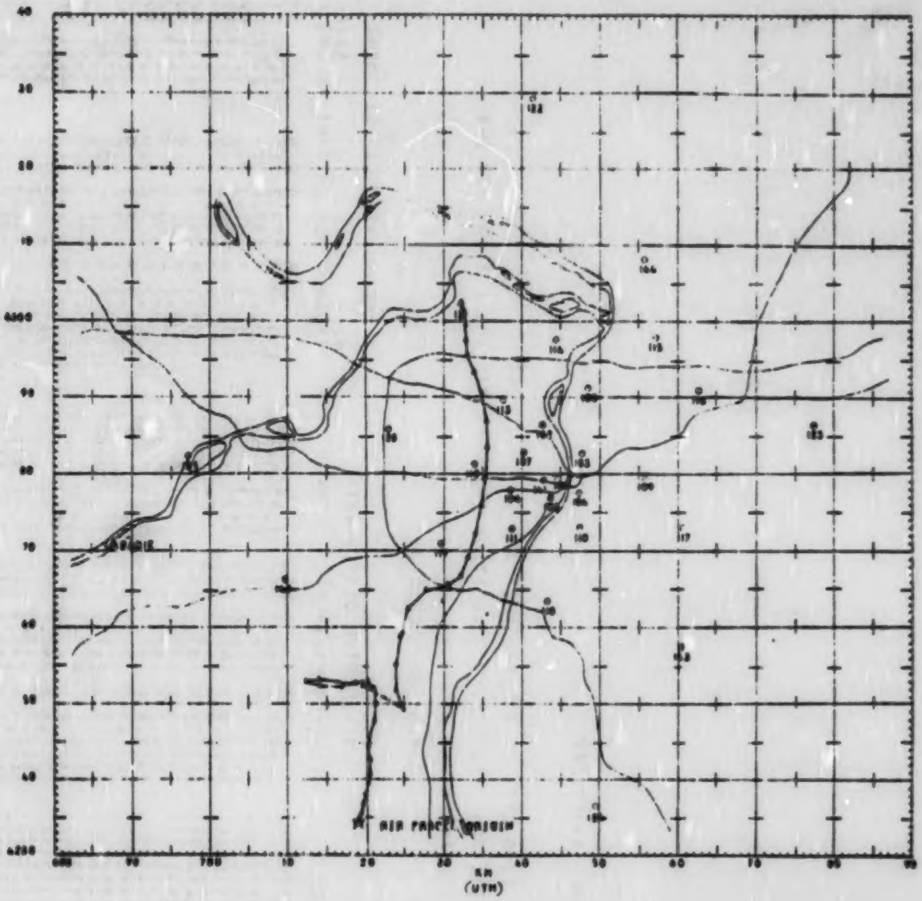
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #7
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 121

STARTING 345 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY
START TIME: 17 JUL 75   945 CST     END TIME: 17 JUL 75  2000 CST
INITIAL COORDINATES: 4302376N. 732414E.     LOCATION DESCRIPTOR: RAMS STATION NO. 121
TRAJECTORY TYPE: BACKWARD IN TIME
STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 41

                                                                                    ACCUMULATED DISPLACEMENT
                                        INCREMENTAL DISPLACEMENT                PATH      AZIMUTH        SPEED
STEP   TIME         LOCATION           RADIAL     AZIMUTH      SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2000 CST  4302376N. 732414E.        0 M      0 DEG      0 M/SEC          0 M       0 DEG        0 M/SEC
  1    1945 CST  4301002N. 732769E.   1418.9 M  165.5 DEG   1.58 M/SEC     1418.9 M   165.5 DEG     1.58 M/SEC
  2    1930 CST  4299445N. 732900E.   1562.8 M  175.2 DEG   1.74 M/SEC     2981.7 M   170.6 DEG     1.66 M/SEC
  3    1915 CST  4297444N. 732929E.   2001.1 M  179.2 DEG   2.22 M/SEC     4982.8 M   174.0 DEG     1.85 M/SEC
  4    1900 CST  4295391N. 733129E.   2062.4 M  174.4 DEG   2.29 M/SEC     7045.2 M   174.1 DEG     1.96 M/SEC
  5    1845 CST  4293239N. 734007E.   2323.6 M  157.8 DEG   2.58 M/SEC     9368.8 M   170.1 DEG     2.08 M/SEC
  6    1830 CST  4290274N. 735039E.   3139.9 M  160.8 DEG   3.49 M/SEC    12508.7 M   167.8 DEG     2.32 M/SEC
  7    1815 CST  4286873N. 735549E.   3439.2 M  171.5 DEG   3.82 M/SEC    15947.9 M   168.6 DEG     2.53 M/SEC
  8    1800 CST  4283481N. 735639E.   3393.0 M  178.5 DEG   3.77 M/SEC    19341.0 M   170.3 DEG     2.69 M/SEC
  9    1745 CST  4279920N. 735395E.   3669.0 M  183.8 DEG   4.08 M/SEC    23009.9 M   172.5 DEG     2.84 M/SEC
 10    1730 CST  4275895N. 734855E.   3961.9 M  187.8 DEG   4.40 M/SEC    26971.9 M   174.7 DEG     3.00 M/SEC
 11    1715 CST  4272234N. 734090E.   3739.9 M  191.8 DEG   4.16 M/SEC    30711.8 M   176.8 DEG     3.10 M/SEC
 12    1700 CST  4269163N. 733116E.   3222.5 M  197.6 DEG   3.58 M/SEC    33934.3 M   178.8 DEG     3.14 M/SEC
 13    1645 CST  4266808N. 732200E.   2526.2 M  201.3 DEG   2.81 M/SEC    36460.4 M   180.3 DEG     3.12 M/SEC
 14    1630 CST  4265673N. 730619E.   1946.5 M  234.3 DEG   2.16 M/SEC    38407.0 M   182.8 DEG     3.05 M/SEC
 15    1615 CST  4264949N. 727795E.   2915.3 M  255.6 DEG   3.24 M/SEC    41322.3 M   187.0 DEG     3.06 M/SEC
 16    1600 CST  4262567N. 725467E.   3330.4 M  224.3 DEG   3.70 M/SEC    44652.7 M   189.9 DEG     3.10 M/SEC
 17    1545 CST  4259910N. 724519E.   3779.3 M  194.5 DEG   4.20 M/SEC    48431.0 M   190.3 DEG     3.17 M/SEC
 18    1530 CST  4255291N. 723902E.   3671.3 M  189.7 DEG   4.08 M/SEC    52102.3 M   190.2 DEG     3.22 M/SEC
 19    1515 CST  4251934N. 723857E.   3356.5 M  180.8 DEG   3.73 M/SEC    55458.7 M   189.6 DEG     3.24 M/SEC
 20    1500 CST  4249400N. 724845E.   2719.9 M  158.7 DEG   3.02 M/SEC    58178.5 M   188.1 DEG     3.23 M/SEC
 21    1445 CST  4249912N. 724198E.    824.6 M  308.3 DEG   0.92 M/SEC    59003.2 M   188.9 DEG     3.12 M/SEC
 22    1430 CST  4252524N. 719661E.   5235.5 M  299.9 DEG   5.82 M/SEC    64238.7 M   194.3 DEG     3.24 M/SEC
 23    1415 CST  4253390N. 714641E.   5685.6 M  278.8 DEG   6.32 M/SEC    69924.3 M   200.6 DEG     3.38 M/SEC
 24    1400 CST  4253091N. 712402E.   1666.0 M  259.7 DEG   1.85 M/SEC    71590.3 M   202.1 DEG     3.31 M/SEC
 25    1345 CST  4252941N. 712983E.    599.4 M  104.5 DEG   0.67 M/SEC    72189.6 M   201.5 DEG     3.21 M/SEC
 26    1330 CST  4252484N. 714282E.   1377.5 M  109.4 DEG   1.53 M/SEC    73567.1 M   200.0 DEG     3.14 M/SEC
 27    1315 CST  4252399N. 716964E.   2683.8 M   92.0 DEG   2.98 M/SEC    76250.9 M   197.2 DEG     3.14 M/SEC
 28    1300 CST  4252975N. 718685E.   1789.6 M   74.2 DEG   1.99 M/SEC    78039.4 M   195.5 DEG     3.10 M/SEC
 29    1245 CST  4253134N. 720268E.   1603.7 M   80.7 DEG   1.78 M/SEC    79643.1 M   193.9 DEG     3.05 M/SEC
 30    1230 CST  4252091N. 721145E.   1363.1 M  139.9 DEG   1.51 M/SEC    81006.1 M   192.6 DEG     3.00 M/SEC
 31    1215 CST  4250135N. 721270E.   1960.5 M  176.4 DEG   2.18 M/SEC    82966.6 M   192.0 DEG     2.97 M/SEC
 32    1200 CST  4247915N. 721082E.   2227.7 M  184.8 DEG   2.48 M/SEC    85194.2 M   191.8 DEG     2.96 M/SEC
 33    1145 CST  4245873N. 720490E.   2125.7 M  196.2 DEG   2.36 M/SEC    87319.9 M   191.9 DEG     2.94 M/SEC
 34    1130 CST  4244599N. 720355E.   1281.0 M  186.1 DEG   1.42 M/SEC    88600.8 M   191.8 DEG     2.90 M/SEC
 35    1115 CST  4242839N. 720590E.   1774.5 M  172.7 DEG   1.97 M/SEC    90375.3 M   191.2 DEG     2.87 M/SEC
 36    1100 CST  4241029N. 720566E.   1810.2 M  180.4 DEG   2.01 M/SEC    92185.4 M   190.9 DEG     2.85 M/SEC
 37    1045 CST  4239795N. 720296E.   1263.0 M  192.3 DEG   1.40 M/SEC    93448.4 M   191.0 DEG     2.81 M/SEC
 38    1030 CST  4238406N. 719953E.   1431.2 M  193.9 DEG   1.59 M/SEC    94879.6 M   191.0 DEG     2.77 M/SEC
 39    1015 CST  4237074N. 719648E.   1365.9 M  192.9 DEG   1.52 M/SEC    96245.4 M   191.1 DEG     2.74 M/SEC
 40    1000 CST  4235838N. 719378E.   1265.0 M  192.3 DEG   1.41 M/SEC    97510.4 M   191.1 DEG     2.71 M/SEC
 41     945 CST  4234687N. 718954E.   1227.1 M  200.2 DEG   1.36 M/SEC    98737.5 M   191.2 DEG     2.68 M/SEC
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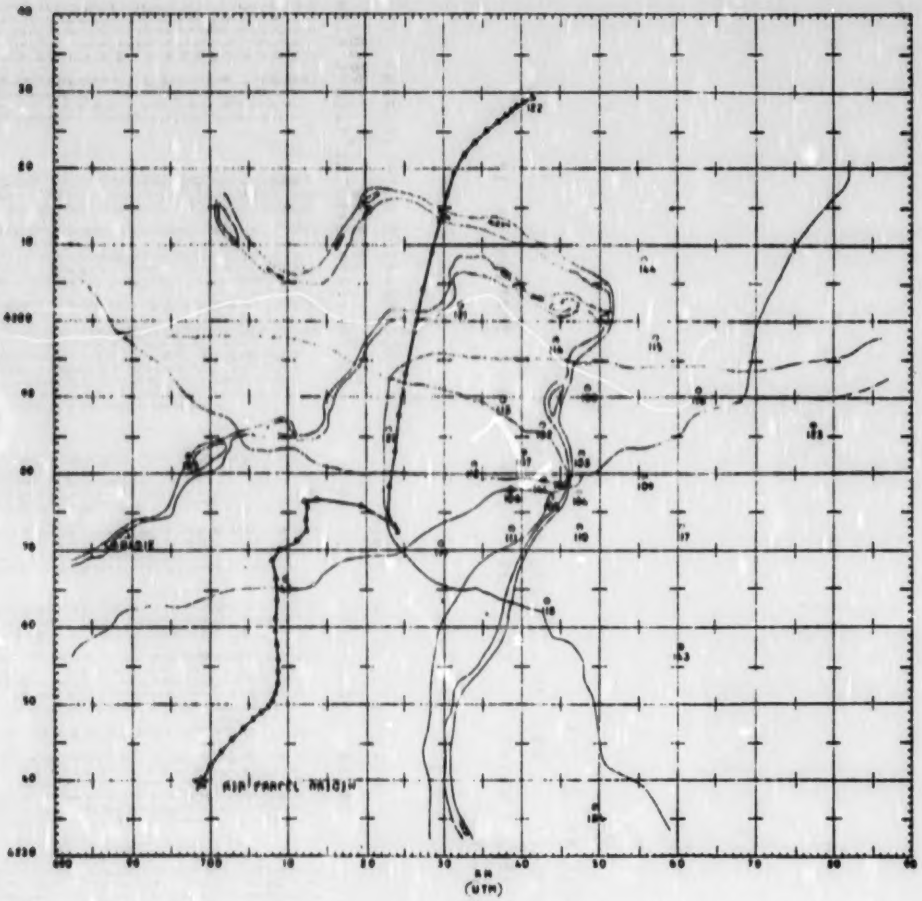
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122
LABADIE
AIR PARCEL ORIGIN

RAMS NEAR SFC
TRAJECTORY #8
ST. LOUIS. MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 122

STARTING 800 CST 17 JUL 75
ARRIVING 2000 CST 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 17 JUL 75   800 CST     END TIME: 17 JUL 75  2000 CST

    INITIAL COORDINATES: 4329223N. 741631E.      LOCATION DESCRIPTOR: RAMS STATION NO. 122

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN         NUMBER OF STEPS: 48

                                                                                            ACCUMULATED DISPLACEMENT
                                            INCREMENTAL DISPLACEMENT               PATH       AZIMUTH          SPEED
STEP   TIME          LOCATION           RADIAL     AZIMUTH       SPEED          LENGTH   (FROM ORIGIN)   (ALONG PATH)

  0   2000 CST   4329223N.  741631E.       0 M      0 DEG      0 M/SEC          0 M       0 DEG       0 M/SEC
  1   1945 CST   4328554N.  740497E.  1316.1 M  239.5 DEG   1.46 M/SEC     1316.1 M   239.5 DEG    1.46 M/SEC
  2   1930 CST   4327984N.  739644E.  1025.9 M  236.2 DEG   1.14 M/SEC     2341.9 M   238.1 DEG    1.30 M/SEC
  3   1915 CST   4327424N.  738991E.   860.8 M  229.4 DEG   0.96 M/SEC     3202.8 M   235.7 DEG    1.19 M/SEC
  4   1900 CST   4326802N.  738280E.   944.2 M  228.9 DEG   1.05 M/SEC     4147.0 M   234.2 DEG    1.15 M/SEC
  5   1845 CST   4325991N.  737282E.  1296.1 M  230.9 DEG   1.43 M/SEC     5433.1 M   233.4 DEG    1.21 M/SEC
  6   1830 CST   4324738N.  735787E.  1912.0 M  231.4 DEG   2.12 M/SEC     7345.1 M   232.9 DEG    1.36 M/SEC
  7   1815 CST   4323353N.  734283E.  2085.6 M  226.2 DEG   2.32 M/SEC     9430.7 M   231.4 DEG    1.50 M/SEC
  8   1800 CST   4321691N.  732901E.  2161.7 M  219.7 DEG   2.40 M/SEC    11592.4 M   229.2 DEG    1.61 M/SEC
  9   1745 CST   4319378N.  731630E.  2639.1 M  208.8 DEG   2.93 M/SEC    14231.6 M   225.5 DEG    1.76 M/SEC
 10   1730 CST   4316427N.  730650E.  3109.7 M  198.4 DEG   3.46 M/SEC    17341.2 M   220.6 DEG    1.93 M/SEC
 11   1715 CST   4312986N.  729745E.  3558.2 M  194.7 DEG   3.95 M/SEC    20899.4 M   216.2 DEG    2.11 M/SEC
 12   1700 CST   4308971N.  728743E.  4137.6 M  194.0 DEG   4.60 M/SEC    25037.1 M   212.5 DEG    2.32 M/SEC
 13   1645 CST   4304125N.  727542E.  4992.4 M  193.9 DEG   5.55 M/SEC    30029.5 M   209.3 DEG    2.57 M/SEC
 14   1630 CST   4298736N.  726446E.  5499.6 M  191.5 DEG   6.11 M/SEC    35529.1 M   206.5 DEG    2.82 M/SEC
 15   1615 CST   4293100N.  725291E.  5755.4 M  191.7 DEG   6.39 M/SEC    41284.5 M   204.4 DEG    3.06 M/SEC
 16   1600 CST   4287772N.  724383E.  5402.8 M  189.6 DEG   6.00 M/SEC    46687.3 M   202.6 DEG    3.24 M/SEC
 17   1545 CST   4283035N.  723998E.  4760.8 M  185.8 DEG   5.29 M/SEC    51448.1 M   201.0 DEG    3.30 M/SEC
 18   1530 CST   4278480N.  723119E.  4622.5 M  189.7 DEG   5.14 M/SEC    56070.6 M   200.0 DEG    3.46 M/SEC
 19   1515 CST   4274724N.  722941E.  3759.8 M  182.7 DEG   4.18 M/SEC    59830.4 M   198.9 DEG    3.50 M/SEC
 20   1500 CST   4272516N.  724185E.  2534.9 M  150.6 DEG   2.82 M/SEC    62365.3 M   197.1 DEG    3.46 M/SEC
 21   1445 CST   4273276N.  723328E.   835.8 M  335.5 DEG   0.93 M/SEC    63201.1 M   197.6 DEG    3.34 M/SEC
 22   1430 CST   4275958N.  719523E.  5028.4 M  300.9 DEG   5.59 M/SEC    68229.6 M   202.5 DEG    3.45 M/SEC
 23   1415 CST   4276729N.  713834E.  5755.1 M  278.7 DEG   6.39 M/SEC    73984.6 M   207.9 DEG    3.57 M/SEC
 24   1400 CST   4276473N.  712269E.  1587.6 M  260.7 DEG   1.76 M/SEC    75572.2 M   209.1 DEG    3.50 M/SEC
 25   1345 CST   4275734N.  712655E.   789.9 M  150.7 DEG   0.88 M/SEC    76362.0 M   208.5 DEG    3.39 M/SEC
 26   1330 CST   4274120N.  712485E.  1673.2 M  165.8 DEG   1.86 M/SEC    78035.1 M   207.9 DEG    3.33 M/SEC
 27   1315 CST   4272772N.  712561E.  1350.0 M  176.8 DEG   1.50 M/SEC    79385.1 M   207.2 DEG    3.27 M/SEC
 28   1300 CST   4271316N.  711219E.  1979.3 M  222.7 DEG   2.20 M/SEC    81364.4 M   207.7 DEG    3.23 M/SEC
 29   1245 CST   4270177N.  709048E.  2452.5 M  242.3 DEG   2.72 M/SEC    83816.8 M   208.9 DEG    3.21 M/SEC
 30   1230 CST   4268927N.  708100E.  1648.6 M  215.1 DEG   1.83 M/SEC    85465.4 M   209.0 DEG    3.17 M/SEC
 31   1215 CST   4266476N.  708615E.  2407.2 M  167.6 DEG   2.67 M/SEC    87872.6 M   207.8 DEG    3.15 M/SEC
 32   1200 CST   4263780N.  708678E.  2696.5 M  178.7 DEG   3.00 M/SEC    90569.3 M   206.7 DEG    3.14 M/SEC
 33   1145 CST   4261274N.  709502E.  2512.7 M  184.0 DEG   2.79 M/SEC    93081.7 M   206.0 DEG    3.13 M/SEC
 34   1130 CST   4259712N.  708480E.  1562.0 M  180.8 DEG   1.74 M/SEC    94643.6 M   205.5 DEG    3.09 M/SEC
 35   1115 CST   4257884N.  708655E.  1836.5 M  174.5 DEG   2.04 M/SEC    96480.1 M   204.8 DEG    3.06 M/SEC
 36   1100 CST   4255984N.  709797E.  1905.3 M  175.7 DEG   2.12 M/SEC    98385.4 M   204.1 DEG    3.04 M/SEC
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37   1045 CST   4254501N.  708806E.   1483.1 M 179.7 DEG   1.65 M/SEC    99868.5 M 203.7 DEG    3.00 M/SEC
38   1030 CST   4253001N.  709741E.   1501.3 M 182.5 DEG   1.67 M/SEC   101369.8 M 203.3 DEG    2.96 M/SEC
39   1015 CST   4251778N.  708426E.   1262.5 M 194.4 DEG   1.40 M/SEC   102632.3 M 203.2 DEG    2.92 M/SEC
40   1000 CST   4250753N.  709049E.   1092.1 M 200.2 DEG   1.21 M/SEC   103724.3 M 203.2 DEG    2.88 M/SEC
41    945 CST   4249932N.  707520E.    977.1 M 212.8 DEG   1.09 M/SEC   104701.4 M 203.3 DEG    2.84 M/SEC
42    930 CST   4249222N.  706605E.   1157.1 M 232.2 DEG   1.29 M/SEC   105858.5 M 203.6 DEG    2.80 M/SEC
43    915 CST   4248313N.  705839E.   1401.3 M 229.5 DEG   1.56 M/SEC   107259.8 M 204.0 DEG    2.77 M/SEC
44    900 CST   4247134N.  704293E.   1715.9 M 226.6 DEG   1.91 M/SEC   108975.7 M 204.5 DEG    2.75 M/SEC
45    845 CST   4245661N.  702834E.   2073.2 M 224.7 DEG   2.30 M/SEC   111048.9 M 204.9 DEG    2.74 M/SEC
46    830 CST   4244071N.  701383E.   2152.3 M 222.4 DEG   2.39 M/SEC   113201.2 M 205.3 DEG    2.73 M/SEC
47    815 CST   4242242N.  700037E.   2271.1 M 216.3 DEG   2.52 M/SEC   115472.3 M 205.6 DEG    2.73 M/SEC
48    800 CST   4240073N.  698829E.   2482.6 M 209.1 DEG   2.76 M/SEC   117954.8 M 205.6 DEG    2.73 M/SEC
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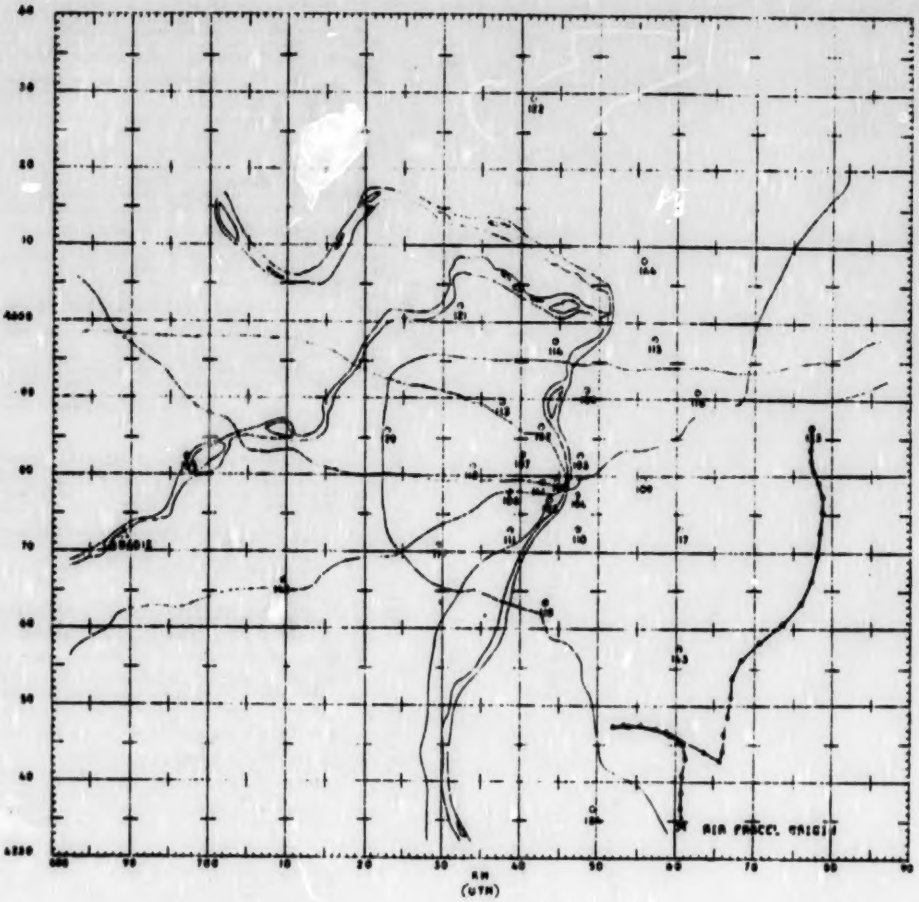
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KM
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AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #9
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 123

STARTING 1130 CDT 17 JUL 75
ARRIVING 2000 CDT 17 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 17 JUL 75  1130 CST     END TIME: 17 JUL 75  2000 CST

     INITIAL COORDINATES: 4286379N. 777320E.     LOCATION DESCRIPTOR: RAMS STATION NO. 123

     TRAJECTORY TYPE: BACKWARD IN TIME

     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 34

                                                                                  ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT            PATH      AZIMUTH         SPEED
STEP   TIME        LOCATION          RADIAL    AZIMUTH      SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)
  0   2000 CST  4286379N. 777320E.        0 M      0 DEG      0 M/SEC           0 M      0 DEG      0 M/SEC
  1   1945 CST  4284899N. 777329E.   1479.6 M  179.6 DEG   1.64 M/SEC      1479.6 M  179.6 DEG   1.64 M/SEC
  2   1930 CST  4283509N. 777230E.   1312.8 M  184.3 DEG   1.46 M/SEC      2792.4 M  181.8 DEG   1.55 M/SEC
  3   1915 CST  4282243N. 777279E.   1347.3 M  177.9 DEG   1.50 M/SEC      4139.7 M  180.6 DEG   1.53 M/SEC
  4   1900 CST  4280843N. 777590E.   1434.2 M  167.5 DEG   1.59 M/SEC      5573.9 M  177.2 DEG   1.55 M/SEC
  5   1845 CST  4279324N. 778239E.   1651.5 M  156.9 DEG   1.84 M/SEC      7225.4 M  172.6 DEG   1.61 M/SEC
  6   1830 CST  4277577N. 778740E.   1816.9 M  164.0 DEG   2.02 M/SEC      9042.4 M  170.8 DEG   1.67 M/SEC
  7   1815 CST  4275575N. 778724E.   2002.7 M  180.4 DEG   2.23 M/SEC     11045.1 M  172.6 DEG   1.75 M/SEC
  8   1800 CST  4272933N. 778464E.   2654.7 M  185.6 DEG   2.95 M/SEC     13699.8 M  175.1 DEG   1.90 M/SEC
  9   1745 CST  4269764N. 778050E.   3195.8 M  187.4 DEG   3.55 M/SEC     16895.6 M  177.5 DEG   2.09 M/SEC
 10   1730 CST  4266631N. 777354E.   3209.6 M  192.5 DEG   3.57 M/SEC     20105.2 M  179.9 DEG   2.23 M/SEC
 11   1715 CST  4263594N. 776014E.   3328.3 M  203.7 DEG   3.70 M/SEC     23433.4 M  183.3 DEG   2.37 M/SEC
 12   1700 CST  4260927N. 773668E.   3544.6 M  221.4 DEG   3.94 M/SEC     26978.1 M  188.2 DEG   2.50 M/SEC
 13   1645 CST  4258505N. 770727E.   3807.1 M  230.6 DEG   4.23 M/SEC     30785.1 M  193.3 DEG   2.63 M/SEC
 14   1630 CST  4256199N. 768346E.   3317.2 M  225.9 DEG   3.69 M/SEC     34102.3 M  196.6 DEG   2.71 M/SEC
 15   1615 CST  4253923N. 767233E.   2534.0 M  206.1 DEG   2.82 M/SEC     36636.3 M  197.3 DEG   2.71 M/SEC
 16   1600 CST  4251423N. 757020E.   2509.3 M  184.9 DEG   2.79 M/SEC     39145.6 M  196.4 DEG   2.72 M/SEC
 17   1545 CST  4248852N. 766646E.   2597.5 M  188.3 DEG   2.89 M/SEC     41743.1 M  195.9 DEG   2.73 M/SEC
 18   1530 CST  4246446N. 766145E.   2457.7 M  191.8 DEG   2.73 M/SEC     44200.7 M  195.6 DEG   2.73 M/SEC
 19   1515 CST  4244352N. 766025E.   2098.1 M  183.3 DEG   2.33 M/SEC     46298.9 M  195.0 DEG   2.71 M/SEC
 20   1500 CST  4243057N. 765682E.   1339.5 M  194.9 DEG   1.49 M/SEC     47638.4 M  195.0 DEG   2.65 M/SEC
 21   1445 CST  4244221N. 763686E.   2310.6 M  300.3 DEG   2.57 M/SEC     49949.0 M  197.9 DEG   2.64 M/SEC
 22   1430 CST  4246867N. 758832E.   5528.8 M  298.6 DEG   6.14 M/SEC     55477.8 M  205.1 DEG   2.80 M/SEC
 23   1415 CST  4247726N. 753387E.   5512.7 M  279.0 DEG   6.13 M/SEC     60990.5 M  211.8 DEG   2.95 M/SEC
 24   1400 CST  4247494N. 752014E.   1392.2 M  260.4 DEG   1.55 M/SEC     62382.7 M  213.1 DEG   2.89 M/SEC
 25   1345 CST  4247491N. 754042E.   2028.0 M   90.1 DEG   2.25 M/SEC     64410.7 M  210.9 DEG   2.86 M/SEC
 26   1330 CST  4247676N. 755584E.   1552.9 M   83.1 DEG   1.73 M/SEC     65963.6 M  209.3 DEG   2.82 M/SEC
 27   1315 CST  4247242N. 757457E.   1922.5 M  103.0 DEG   2.14 M/SEC     67886.0 M  206.9 DEG   2.79 M/SEC
 28   1300 CST  4246358N. 759413E.   2146.2 M  114.3 DEG   2.38 M/SEC     70032.2 M  204.1 DEG   2.78 M/SEC
 29   1245 CST  4245212N. 760983E.   1944.1 M  126.1 DEG   2.16 M/SEC     71976.3 M  201.6 DEG   2.76 M/SEC
 30   1230 CST  4243384N. 761293E.   1854.6 M  170.4 DEG   2.06 M/SEC     73830.8 M  200.4 DEG   2.73 M/SEC
 31   1215 CST  4241137N. 760864E.   2287.0 M  190.8 DEG   2.54 M/SEC     76117.8 M  200.0 DEG   2.73 M/SEC
 32   1200 CST  4239036N. 760783E.   2102.3 M  182.2 DEG   2.34 M/SEC     78220.1 M  199.3 DEG   2.72 M/SEC
 33   1145 CST  4236598N. 760714E.   2039.6 M  181.9 DEG   2.27 M/SEC     80259.7 M  198.6 DEG   2.70 M/SEC
 34   1130 CST  4234875N. 760832E.   2126.1 M  176.8 DEG   2.36 M/SEC     82385.8 M  197.8 DEG   2.69 M/SEC
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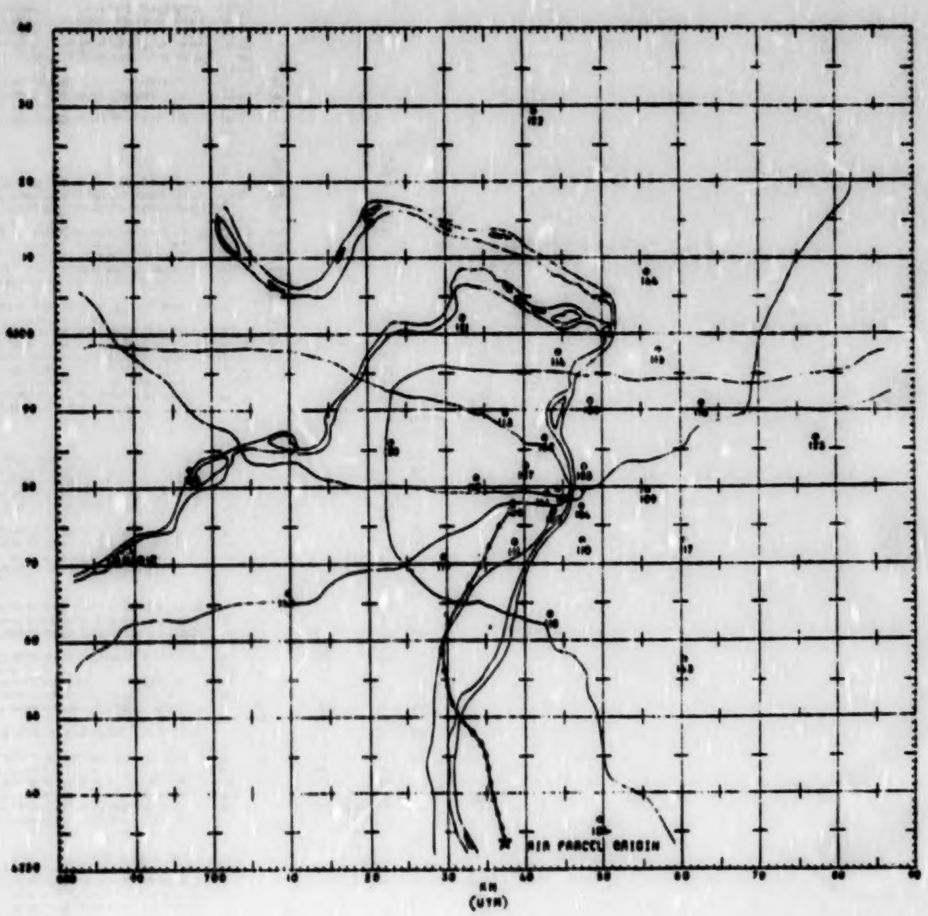
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #10
ST. LOUIS. MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 106

STARTING 245 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 18 JUL 75   245 CST     END TIME: 18 JUL 75   800 CST
    INITIAL COORDINATES: 4277566N. 738660E.     LOCATION DESCRIPTOR: RAMS STATION NO. 106
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 21

                                                                                   ACCUMULATED DISPLACEMENT
                                            INCREMENTAL DISPLACEMENT            PATH      AZIMUTH        SPEED
STEP   TIME        LOCATION           RADIAL     AZIMUTH      SPEED          LENGTH   (FROM ORIGIN) (ALONG PATH)

  0   800 CST  4277566N.  738660E.        0 M      0 DEG      0 M/SEC          0 M      0 DEG      0 M/SEC
  1   745 CST  4274991N.  736910E.   3112.8 M  214.2 DEG   3.46 M/SEC     3112.8 M  214.2 DEG   3.46 M/SEC
  2   730 CST  4272393N.  735638E.   2892.6 M  206.1 DEG   3.21 M/SEC     6005.4 M  210.3 DEG   3.34 M/SEC
  3   715 CST  4269817N.  734467E.   2829.4 M  204.4 DEG   3.14 M/SEC     8834.9 M  208.4 DEG   3.27 M/SEC
  4   700 CST  4267333N.  733123E.   2820.4 M  209.2 DEG   3.13 M/SEC    11655.3 M  208.4 DEG   3.24 M/SEC
  5   645 CST  4264877N.  731636E.   2875.5 M  211.4 DEG   3.19 M/SEC    14530.8 M  209.0 DEG   3.23 M/SEC
  6   630 CST  4262427N.  730440E.   2724.4 M  206.0 DEG   3.03 M/SEC    17255.1 M  208.5 DEG   3.20 M/SEC
  7   615 CST  4260271N.  729827E.   2243.5 M  195.9 DEG   2.49 M/SEC    19498.6 M  207.1 DEG   3.16 M/SEC
  8   600 CST  4258318N.  729674E.   1958.9 M  184.5 DEG   2.18 M/SEC    21457.5 M  205.0 DEG   2.98 M/SEC
  9   545 CST  4256320N.  729849E.   2005.4 M  175.0 DEG   2.23 M/SEC    23463.9 M  202.5 DEG   2.90 M/SEC
 10   530 CST  4254209N.  730229E.   2144.5 M  169.8 DEG   2.38 M/SEC    25608.5 M  199.8 DEG   2.85 M/SEC
 11   515 CST  4251946N.  730880E.   2355.3 M  163.9 DEG   2.62 M/SEC    27963.8 M  196.9 DEG   2.82 M/SEC
 12   500 CST  4249820N.  732058E.   2430.3 M  151.0 DEG   2.70 M/SEC    30394.1 M  193.4 DEG   2.81 M/SEC
 13   445 CST  4248177N.  733510E.   2192.4 M  138.5 DEG   2.44 M/SEC    32586.5 M  189.9 DEG   2.79 M/SEC
 14   430 CST  4246777N.  734526E.   1729.1 M  144.0 DEG   1.92 M/SEC    34315.6 M  187.6 DEG   2.72 M/SEC
 15   415 CST  4245272N.  735070E.   1600.7 M  160.1 DEG   1.78 M/SEC    35916.3 M  186.3 DEG   2.66 M/SEC
 16   400 CST  4243557N.  735405E.   1747.5 M  169.0 DEG   1.94 M/SEC    37664.3 M  185.5 DEG   2.62 M/SEC
 17   345 CST  4241578N.  735659E.   1995.2 M  172.7 DEG   2.22 M/SEC    39659.5 M  184.8 DEG   2.59 M/SEC
 18   330 CST  4239591N.  736045E.   2023.7 M  169.0 DEG   2.25 M/SEC    41683.1 M  183.9 DEG   2.57 M/SEC
 19   315 CST  4237727N.  736578E.   1939.1 M  164.0 DEG   2.15 M/SEC    43622.2 M  183.0 DEG   2.55 M/SEC
 20   300 CST  4235856N.  737071E.   1934.5 M  165.2 DEG   2.15 M/SEC    45556.7 M  182.2 DEG   2.53 M/SEC
 21   245 CST  4233954N.  737414E.   1932.8 M  169.4 DEG   2.15 M/SEC    47489.5 M  181.6 DEG   2.51 M/SEC
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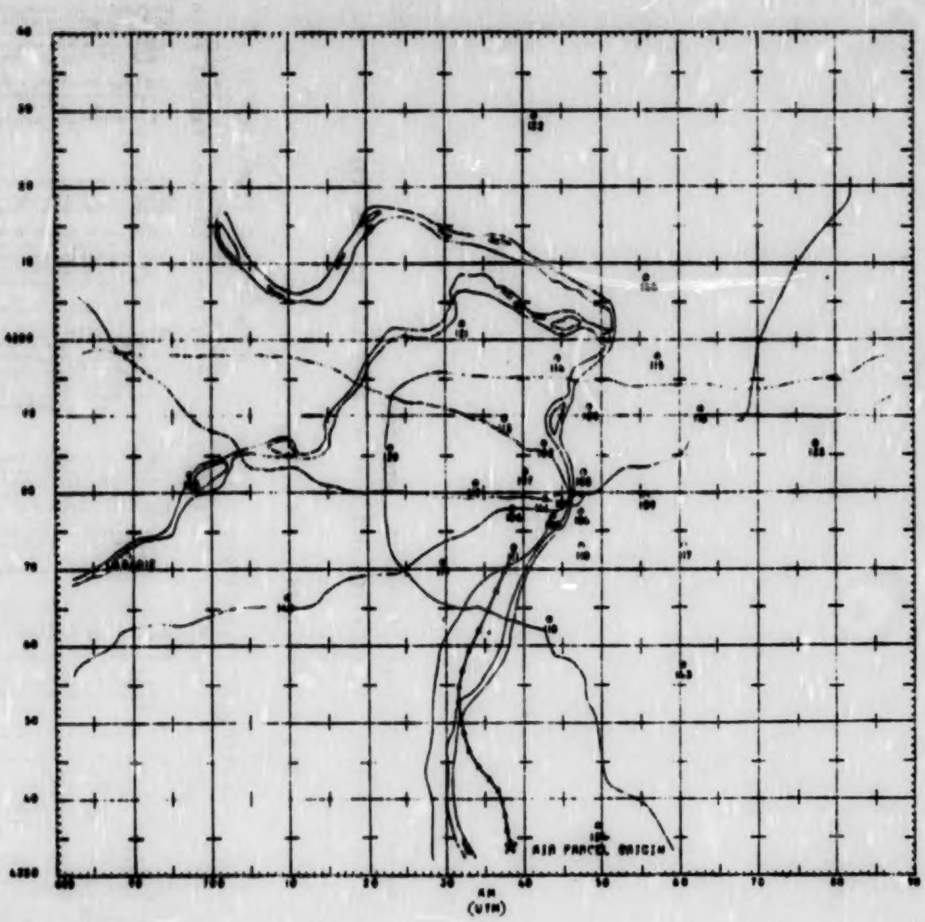
AIR PARCEL ORIGIN
KM
(UTM)
4300
4250
90
100
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RAMS NEAR-SFC
TRAJECTORY #11
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 111

STARTING 330 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 18 JUL 75   330 CST      END TIME: 18 JUL 75   800 CST
    INITIAL COORDINATES: 4272479N. 738912E.     LOCATION DESCRIPTOR: RAMS STATION NO. 111
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 18

                                                                                    ACCUMULATED DISPLACEMENT
                                               INCREMENTAL DISPLACEMENT        PATH       AZIMUTH          SPEED
STEP   TIME         LOCATION              RADIAL    AZIMUTH      SPEED        LENGTH   (FROM ORIGIN)   (ALONG PATH)

  0    800 CST   4272479N. 738912E.          0 M       0 DEG      0 M/SEC          0 M      0 DEG       0 M/SEC
  1    745 CST   4269780N. 737601E.     2957.2 M   204.2 DEG   3.29 M/SEC     2957.2 M  204.2 DEG    3.29 M/SEC
  2    730 CST   4267225N. 736542E.     2766.0 M   202.5 DEG   3.07 M/SEC     5723.1 M  203.4 DEG    3.18 M/SEC
  3    715 CST   4264773N. 735532E.     2652.5 M   202.4 DEG   2.95 M/SEC     8375.6 M  203.1 DEG    3.10 M/SEC
  4    700 CST   4262141N. 734325E.     2895.2 M   204.6 DEG   3.22 M/SEC    11270.8 M  203.5 DEG    3.13 M/SEC
  5    645 CST   4259403N. 733079E.     3009.7 M   204.5 DEG   3.34 M/SEC    14280.6 M  203.7 DEG    3.17 M/SEC
  6    630 CST   4256917N. 732217E.     2630.1 M   199.0 DEG   2.92 M/SEC    16910.7 M  203.0 DEG    3.13 M/SEC
  7    615 CST   4254904N. 731770E.     2159.5 M   191.9 DEG   2.40 M/SEC    19070.2 M  201.7 DEG    3.03 M/SEC
  8    600 CST   4252970N. 731715E.     1934.9 M   181.6 DEG   2.15 M/SEC    21005.1 M  199.9 DEG    2.92 M/SEC
  9    545 CST   4250935N. 731958E.     1980.5 M   173.0 DEG   2.20 M/SEC    22985.6 M  197.6 DEG    2.84 M/SEC
 10    530 CST   4248809N. 732383E.     2138.2 M   168.5 DEG   2.38 M/SEC    25123.8 M  195.2 DEG    2.79 M/SEC
 11    515 CST   4246550N. 733057E.     2357.3 M   163.4 DEG   2.62 M/SEC    27481.1 M  192.5 DEG    2.78 M/SEC
 12    500 CST   4244433N. 734239E.     2425.1 M   150.8 DEG   2.69 M/SEC    29906.2 M  189.3 DEG    2.77 M/SEC
 13    445 CST   4242788N. 735689E.     2192.6 M   138.6 DEG   2.44 M/SEC    32098.9 M  186.0 DEG    2.74 M/SEC
 14    430 CST   4241393N. 736707E.     1734.7 M   144.1 DEG   1.93 M/SEC    33833.4 M  183.9 DEG    2.69 M/SEC
 15    415 CST   4239877N. 737253E.     1602.3 M   160.1 DEG   1.78 M/SEC    35435.9 M  182.7 DEG    2.62 M/SEC
 16    400 CST   4238161N. 737877E.     1747.7 M   159.0 DEG   1.94 M/SEC    37183.4 M  182.0 DEG    2.58 M/SEC
 17    345 CST   4236181N. 737839E.     1995.9 M   172.7 DEG   2.22 M/SEC    39179.3 M  181.5 DEG    2.56 M/SEC
 18    330 CST   4234194N. 739223E.     2024.0 M   159.1 DEG   2.25 M/SEC    41203.3 M  180.9 DEG    2.54 M/SEC
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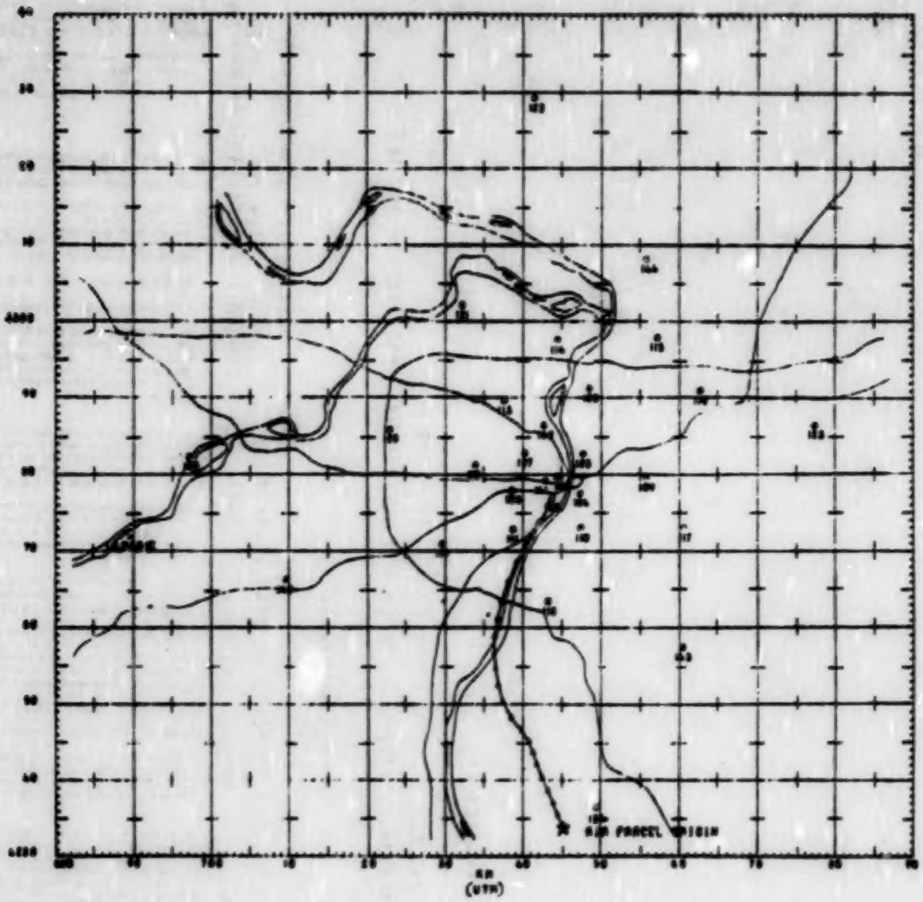

RAMS NEAR-SFC
TRAJECTORY #12
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 105

STARTING 245 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 18 JUL 75   245 CST     END TIME: 18 JUL 75   800 CST
     INITIAL COORDINATES: 4276453N. 743706E.     LOCATION DESCRIPTOR: RAMS STATION NO. 105
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 21

                                                                                ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT
                                                                          PATH        AZIMUTH          SPEED
STEP   TIME         LOCATION            RADIAL    AZIMUTH       SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    800 CST   4276453N.  743706E.       0 M       0 DEG        0 M/SEC          0 M       0 DEG        0 M/SEC
  1    745 CST   4273817N.  742016E.  3130.3 M   212.7 DEG     3.48 M/SEC     3130.3 M   212.7 DEG     3.48 M/SEC
  2    730 CST   4271260N.  740485E.  2980.7 M   210.9 DEG     3.31 M/SEC     6111.0 M   211.8 DEG     3.39 M/SEC
  3    715 CST   4268573N.  739247E.  2867.4 M   205.6 DEG     3.19 M/SEC     8978.4 M   209.9 DEG     3.33 M/SEC
  4    700 CST   4266096N.  738151E.  2800.8 M   203.0 DEG     3.11 M/SEC    11779.2 M   208.2 DEG     3.27 M/SEC
  5    645 CST   4263505N.  737289E.  2645.0 M   199.0 DEG     2.94 M/SEC    14425.2 M   206.5 DEG     3.21 M/SEC
  6    630 CST   4261271N.  736762E.  2382.6 M   192.8 DEG     2.65 M/SEC    16807.7 M   204.6 DEG     3.11 M/SEC
  7    615 CST   4259128N.  736402E.  2172.6 M   189.5 DEG     2.41 M/SEC    18980.3 M   202.9 DEG     3.01 M/SEC
  8    600 CST   4257030N.  736361E.  2099.2 M   181.7 DEG     2.33 M/SEC    21079.5 M   200.8 DEG     2.93 M/SEC
  9    545 CST   4254619N.  736129E.  2119.8 M   174.9 DEG     2.36 M/SEC    23199.3 M   198.4 DEG     2.86 M/SEC
 10    530 CST   4252779N.  736854E.  2163.9 M   171.4 DEG     2.40 M/SEC    25363.2 M   196.1 DEG     2.82 M/SEC
 11    515 CST   4250579N.  737438E.  2276.1 M   165.1 DEG     2.53 M/SEC    27639.4 M   193.6 DEG     2.79 M/SEC
 12    500 CST   4249512N.  738438E.  2318.8 M   153.1 DEG     2.58 M/SEC    29958.2 M   190.6 DEG     2.77 M/SEC
 13    445 CST   4246842N.  739788E.  2115.7 M   142.1 DEG     2.35 M/SEC    32073.9 M   187.5 DEG     2.74 M/SEC
 14    430 CST   4245431N.  740746E.  1706.5 M   145.8 DEG     1.90 M/SEC    33780.4 M   185.4 DEG     2.68 M/SEC
 15    415 CST   4243994N.  741286E.  1535.0 M   159.4 DEG     1.71 M/SEC    35315.3 M   184.3 DEG     2.62 M/SEC
 16    400 CST   4242435N.  741763E.  1630.3 M   163.0 DEG     1.81 M/SEC    36945.6 M   183.3 DEG     2.57 M/SEC
 17    345 CST   4240746N.  742403E.  1806.0 M   159.3 DEG     2.01 M/SEC    38751.6 M   182.1 DEG     2.53 M/SEC
 18    330 CST   4239014N.  743147E.  1884.8 M   156.7 DEG     2.09 M/SEC    40636.4 M   180.9 DEG     2.51 M/SEC
 19    315 CST   4237412N.  743819E.  1737.3 M   157.2 DEG     1.93 M/SEC    42373.7 M   179.8 DEG     2.48 M/SEC
 20    300 CST   4235837N.  744375E.  1670.3 M   160.6 DEG     1.86 M/SEC    44044.0 M   179.1 DEG     2.45 M/SEC
 21    245 CST   4234190N.  745104E.  1801.4 M   156.1 DEG     2.00 M/SEC    45845.5 M   178.1 DEG     2.43 M/SEC
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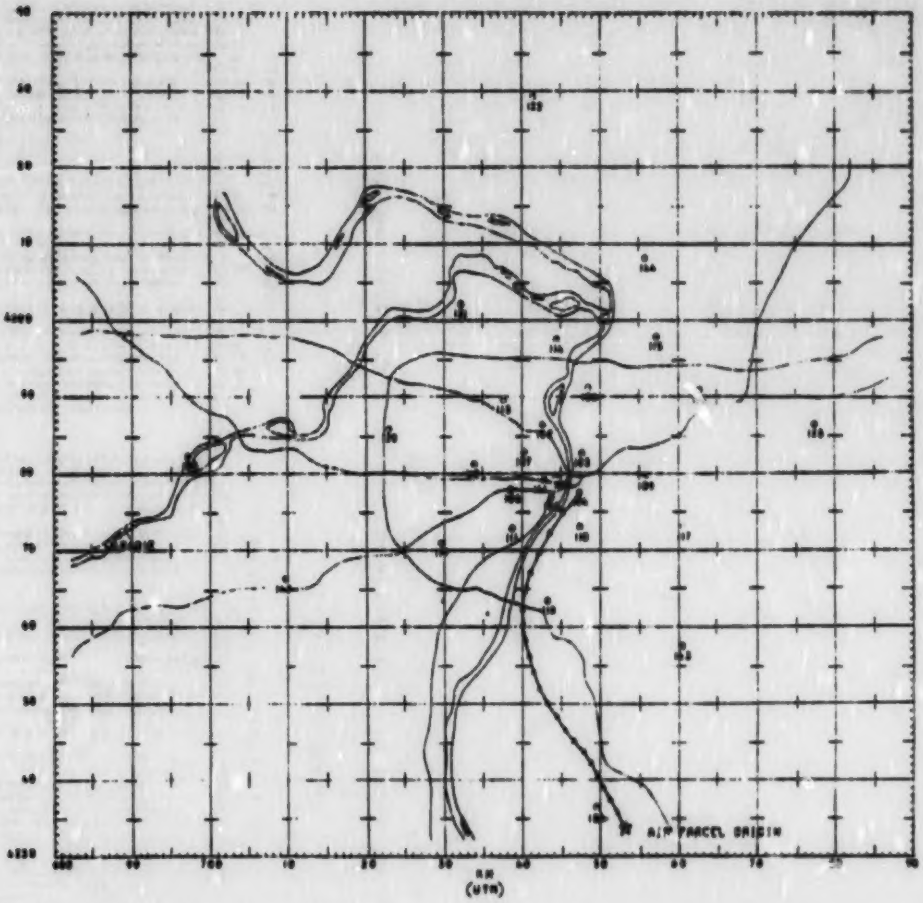
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #13
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 104

STARTING 230 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 18 JUL 75   230 CST     END TIME: 18 JUL 75   800 CST
    INITIAL COORDINATES: 4277304N, 747312E.     LOCATION DESCRIPTOR: RAMS STATION NO. 104
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN           NUMBER OF STEPS: 22

                                                                                      ACCUMULATED DISPLACEMENT
                                               INCREMENTAL DISPLACEMENT          PATH        AZIMUTH          SPEED
STEP   TIME          LOCATION             RADIAL    AZIMUTH        SPEED        LENGTH   (FROM ORIGIN)   (ALONG PATH)

  0    800 CST   4277304N.  747312E.         0 M      0 DEG       0 M/SEC          0 M      0 DEG          0 M/SEC
  1    745 CST   4274877N.  745196E.    3218.8 M  221.1 DEG    3.58 M/SEC     3218.8 M  221.1 DEG       3.58 M/SEC
  2    730 CST   4272262N.  743493E.    3121.3 M  213.1 DEG    3.47 M/SEC     6340.1 M  217.1 DEG       3.52 M/SEC
  3    715 CST   4269685N.  742128E.    2915.7 M  207.9 DEG    3.24 M/SEC     9255.8 M  214.2 DEG       3.43 M/SEC
  4    700 CST   4267160N.  741047E.    2746.7 M  203.2 DEG    3.05 M/SEC    12002.5 M  211.7 DEG       3.33 M/SEC
  5    645 CST   4264657N.  740272E.    2620.5 M  197.2 DEG    2.91 M/SEC    14623.0 M  209.1 DEG       3.25 M/SEC
  6    630 CST   4262412N.  740020E.    2258.8 M  186.4 DEG    2.51 M/SEC    16881.8 M  206.1 DEG       3.13 M/SEC
  7    615 CST   4260369N.  740078E.    2043.7 M  178.3 DEG    2.27 M/SEC    18925.5 M  203.1 DEG       3.00 M/SEC
  8    600 CST   4258328N.  740339E.    2057.6 M  172.7 DEG    2.29 M/SEC    20983.1 M  200.2 DEG       2.91 M/SEC
  9    545 CST   4256337N.  740804E.    2044.6 M  166.9 DEG    2.27 M/SEC    23027.7 M  197.2 DEG       2.84 M/SEC
 10    530 CST   4254262N.  741352E.    2146.2 M  165.2 DEG    2.38 M/SEC    25173.9 M  194.5 DEG       2.80 M/SEC
 11    515 CST   4252124N.  742081E.    2259.3 M  161.2 DEG    2.51 M/SEC    27433.2 M  191.7 DEG       2.77 M/SEC
 12    500 CST   4250174N.  743119E.    2208.5 M  152.0 DEG    2.45 M/SEC    29641.7 M  188.8 DEG       2.74 M/SEC
 13    445 CST   4248398N.  744298E.    2131.9 M  146.4 DEG    2.37 M/SEC    31773.5 M  186.0 DEG       2.72 M/SEC
 14    430 CST   4246743N.  745336E.    1953.6 M  147.9 DEG    2.17 M/SEC    33727.1 M  183.7 DEG       2.68 M/SEC
 15    415 CST   4245286N.  746457E.    1837.5 M  142.4 DEG    2.04 M/SEC    35564.6 M  181.5 DEG       2.63 M/SEC
 16    400 CST   4243875N.  747661E.    1856.3 M  139.5 DEG    2.06 M/SEC    37420.9 M  179.4 DEG       2.60 M/SEC
 17    345 CST   4242393N.  748615E.    1762.1 M  147.2 DEG    1.96 M/SEC    39183.0 M  177.9 DEG       2.56 M/SEC
 18    330 CST   4240846N.  749367E.    1720.2 M  154.1 DEG    1.91 M/SEC    40903.2 M  176.8 DEG       2.52 M/SEC
 19    315 CST   4239294N.  750145E.    1735.9 M  153.4 DEG    1.93 M/SEC    42639.2 M  175.7 DEG       2.49 M/SEC
 20    300 CST   4237744N.  751028E.    1783.9 M  150.3 DEG    1.98 M/SEC    44423.1 M  174.6 DEG       2.47 M/SEC
 21    245 CST   4236026N.  751940E.    1945.5 M  152.0 DEG    2.16 M/SEC    46368.6 M  173.6 DEG       2.45 M/SEC
 22    230 CST   4233966N.  752903E.    2273.1 M  155.0 DEG    2.53 M/SEC    48641.7 M  172.6 DEG       2.46 M/SEC
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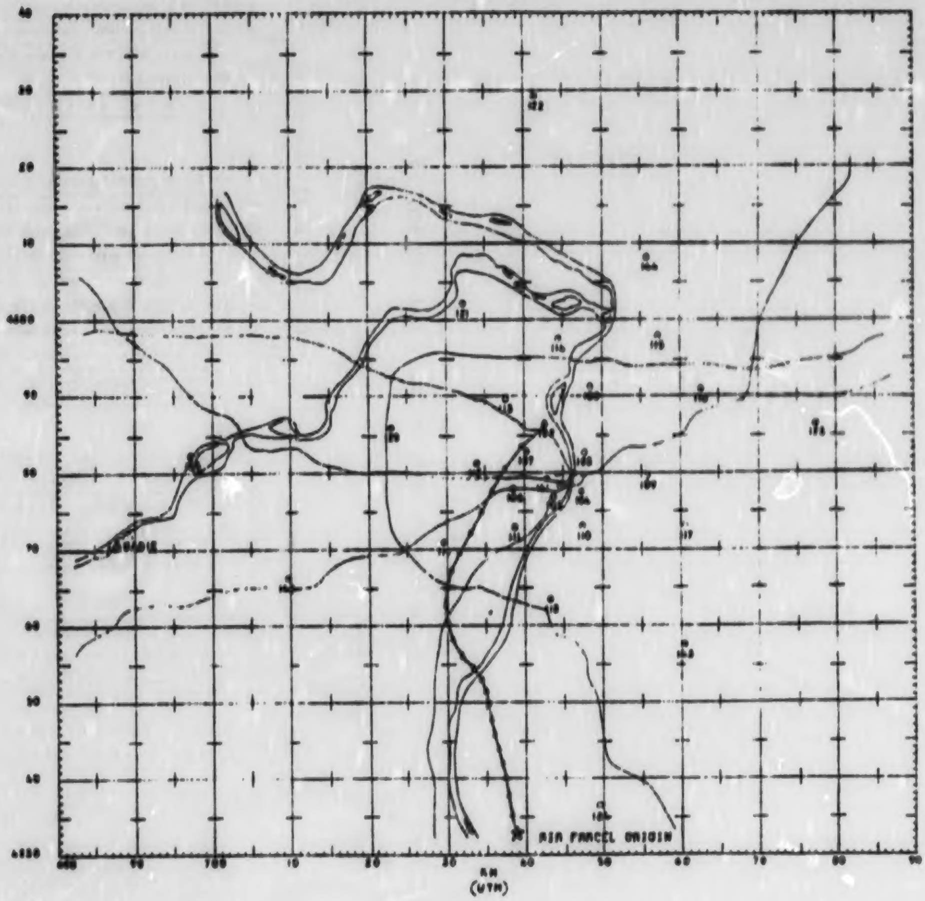
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #14
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 10[illegible]

STARTING 200 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 18 JUL 75   200 CST     END TIME: 18 JUL 75   800 CST
     INITIAL COORDINATES: 4286045N. 742518E.     LOCATION DESCRIPTOR: RAMS STATION NO. 102
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN        NUMBER OF STEPS: 24

                                                                                   ACCUMULATED DISPLACEMENT
                                          INCREMENTAL DISPLACEMENT             PATH      AZIMUTH         SPEED
STEP    TIME           LOCATION          RADIAL     AZIMUTH      SPEED       LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0     800 CST   4286045N.  742518E.        0 M       0 DEG      0 M/SEC         0 M       0 DEG       0 M/SEC
  1     745 CST   4283614N.  739606E.   3924.2 M   227.9 DEG   4.36 M/SEC    3924.2 M   227.9 DEG    4.36 M/SEC
  2     730 CST   4280616N.  737489E.   3508.4 M   217.1 DEG   3.90 M/SEC    7432.6 M   222.8 DEG    4.13 M/SEC
  3     715 CST   4277756N.  735849E.   3297.1 M   209.8 DEG   3.66 M/SEC   10729.7 M   218.8 DEG    3.97 M/SEC
  4     700 CST   4275000N.  734527E.   3055.8 M   205.6 DEG   3.40 M/SEC   13785.5 M   215.9 DEG    3.83 M/SEC
  5     645 CST   4272313N.  733088E.   3048.8 M   208.2 DEG   3.39 M/SEC   16834.3 M   214.5 DEG    3.74 M/SEC
  6     630 CST   4269707N.  731660E.   2970.8 M   208.7 DEG   3.30 M/SEC   19805.2 M   213.6 DEG    3.67 M/SEC
  7     615 CST   4267389N.  730607E.   2547.2 M   204.4 DEG   2.83 M/SEC   22352.3 M   212.6 DEG    3.55 M/SEC
  8     600 CST   4265151N.  730019E.   2313.6 M   194.7 DEG   2.57 M/SEC   24665.9 M   210.9 DEG    3.43 M/SEC
  9     545 CST   4262859N.  729869E.   2295.6 M   183.7 DEG   2.55 M/SEC   26962.5 M   208.6 DEG    3.33 M/SEC
 10     530 CST   4260657N.  730109E.   2214.5 M   173.8 DEG   2.46 M/SEC   29177.0 M   206.0 DEG    3.24 M/SEC
 11     515 CST   4258385N.  730716E.   2351.5 M   165.0 DEG   2.61 M/SEC   31528.5 M   203.1 DEG    3.18 M/SEC
 12     500 CST   4256245N.  731895E.   2439.8 M   151.3 DEG   2.71 M/SEC   33967.3 M   199.6 DEG    3.15 M/SEC
 13     445 CST   4254600N.  733340E.   2196.0 M   138.5 DEG   2.44 M/SEC   36163.3 M   196.3 DEG    3.09 M/SEC
 14     430 CST   4253202N.  734359E.   1730.6 M   143.9 DEG   1.92 M/SEC   37893.9 M   194.0 DEG    3.01 M/SEC
 15     415 CST   4251696N.  734913E.   1606.6 M   159.6 DEG   1.79 M/SEC   39500.6 M   192.5 DEG    2.93 M/SEC
 16     400 CST   4249989N.  735279E.   1745.7 M   168.1 DEG   1.94 M/SEC   41246.3 M   191.4 DEG    2.86 M/SEC
 17     345 CST   4248019N.  735556E.   1987.9 M   172.0 DEG   2.21 M/SEC   43234.2 M   190.4 DEG    2.83 M/SEC
 18     330 CST   4246037N.  735952E.   2020.9 M   168.6 DEG   2.25 M/SEC   45255.0 M   189.3 DEG    2.79 M/SEC
 19     315 CST   4244173N.  736493E.   1941.3 M   163.8 DEG   2.16 M/SEC   47196.3 M   188.2 DEG    2.76 M/SEC
 20     300 CST   4242303N.  737000E.   1937.2 M   164.8 DEG   2.15 M/SEC   49133.5 M   187.2 DEG    2.73 M/SEC
 21     245 CST   4240400N.  737364E.   1937.5 M   169.2 DEG   2.15 M/SEC   51071.0 M   186.4 DEG    2.70 M/SEC
 22     230 CST   4238176N.  737677E.   2245.9 M   172.0 DEG   2.50 M/SEC   53316.9 M   185.8 DEG    2.69 M/SEC
 23     215 CST   4235666N.  738093E.   2544.6 M   170.6 DEG   2.83 M/SEC   55861.4 M   185.0 DEG    2.70 M/SEC
 24     200 CST   4233211N.  739630E.   2512.9 M   167.6 DEG   2.79 M/SEC   58374.4 M   184.2 DEG    2.70 M/SEC
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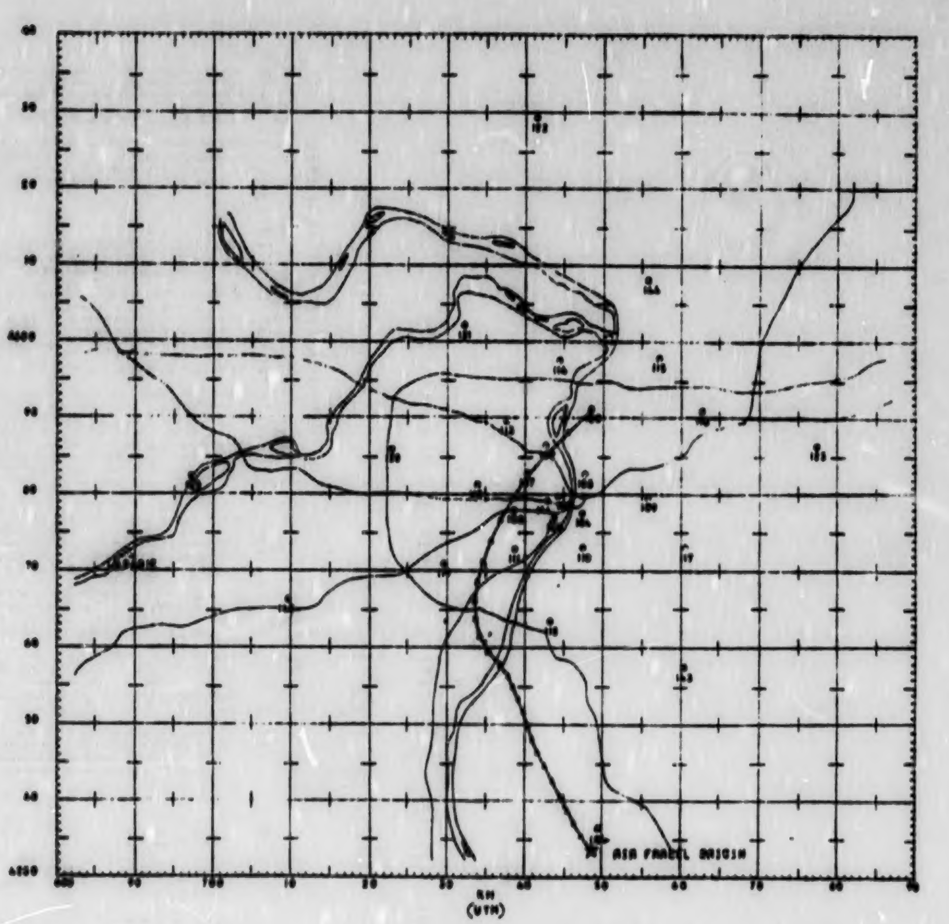
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #15
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 108

STARTING 115 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 18 JUL 75    115 CST      END TIME: 18 JUL 75   800 CST

     INITIAL COORDINATES: 4291102N. 748407E.      LOCATION DESCRIPTOR: RAMS STATION NO. 108

     TRAJECTORY TYPE: BACKWARD IN TIME

     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 27

                                                                                      ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT              PATH        AZIMUTH          SPEED
STEP    TIME         LOCATION            RADIAL     AZIMUTH       SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0     800 CST   4291102N.  748407E.        0 M       0 DEG       0 M/SEC          0 M      0 DEG          0 M/SEC
  1     745 CST   4288211N.  745449E.   4135.6 M   225.6 DEG    4.60 M/SEC     4135.6 M  225.6 DEG       4.60 M/SEC
  2     730 CST   4285280N.  742525E.   4140.1 M   224.9 DEG    4.60 M/SEC     8275.6 M  225.3 DEG       4.60 M/SEC
  3     715 CST   4282493N.  740172E.   3655.1 M   220.1 DEG    4.06 M/SEC    11930.7 M  223.7 DEG       4.42 M/SEC
  4     700 CST   4279701N.  738382E.   3308.2 M   212.7 DEG    3.68 M/SEC    15238.9 M  221.3 DEG       4.23 M/SEC
  5     645 CST   4276897N.  736781E.   3237.2 M   209.6 DEG    3.60 M/SEC    18476.1 M  219.3 DEG       4.11 M/SEC
  6     630 CST   4274137N.  735536E.   3019.9 M   204.4 DEG    3.35 M/SEC    21495.0 M  217.2 DEG       3.98 M/SEC
  7     615 CST   4271476N.  734524E.   2847.4 M   200.8 DEG    3.16 M/SEC    24342.4 M  215.3 DEG       3.86 M/SEC
  8     600 CST   4268804N.  733742E.   2783.7 M   196.3 DEG    3.09 M/SEC    27126.1 M  213.3 DEG       3.77 M/SEC
  9     545 CST   4266397N.  733462E.   2423.5 M   186.6 DEG    2.69 M/SEC    29549.6 M  211.2 DEG       3.65 M/SEC
 10     530 CST   4264115N.  733497E.   2291.9 M   179.1 DEG    2.54 M/SEC    31831.5 M  208.9 DEG       3.54 M/SEC
 11     515 CST   4261965N.  734049E.   2317.1 M   166.2 DEG    2.57 M/SEC    34148.6 M  206.2 DEG       3.45 M/SEC
 12     500 CST   4259744N.  735219E.   2421.9 M   151.1 DEG    2.69 M/SEC    36570.5 M  202.8 DEG       3.39 M/SEC
 13     445 CST   4258063N.  736617E.   2196.2 M   140.3 DEG    2.43 M/SEC    38756.7 M  199.6 DEG       3.31 M/SEC
 14     430 CST   4256623N.  737538E.   1737.9 M   145.6 DEG    1.93 M/SEC    40494.6 M  197.4 DEG       3.21 M/SEC
 15     415 CST   4255182N.  738174E.   1564.3 M   157.6 DEG    1.74 M/SEC    42058.9 M  195.9 DEG       3.12 M/SEC
 16     400 CST   4253638N.  738878E.   1634.9 M   155.3 DEG    1.82 M/SEC    43693.7 M  194.3 DEG       3.03 M/SEC
 17     345 CST   4251371N.  739524E.   1843.9 M   159.5 DEG    2.05 M/SEC    45537.6 M  192.8 DEG       2.98 M/SEC
 18     330 CST   4250105N.  740034E.   1934.3 M   164.7 DEG    2.15 M/SEC    47471.9 M  191.3 DEG       2.93 M/SEC
 19     315 CST   4248409N.  740608E.   1790.1 M   161.3 DEG    1.99 M/SEC    49262.0 M  190.4 DEG       2.88 M/SEC
 20     300 CST   4246735N.  741297E.   1809.8 M   157.5 DEG    2.01 M/SEC    51071.9 M  189.1 DEG       2.84 M/SEC
 21     245 CST   4244962N.  742130E.   1980.7 M   153.5 DEG    2.20 M/SEC    53052.6 M  187.7 DEG       2.81 M/SEC
 22     230 CST   4243015N.  743158E.   2179.2 M   153.3 DEG    2.42 M/SEC    55231.8 M  186.2 DEG       2.79 M/SEC
 23     215 CST   4240969N.  744131E.   2266.2 M   154.6 DEG    2.52 M/SEC    57497.9 M  184.9 DEG       2.78 M/SEC
 24     200 CST   4239159N.  745021E.   2017.4 M   153.8 DEG    2.24 M/SEC    59515.3 M  183.7 DEG       2.76 M/SEC
 25     145 CST   4237555N.  745946E.   1802.5 M   152.8 DEG    2.00 M/SEC    61317.8 M  182.7 DEG       2.73 M/SEC
 26     130 CST   4235925N.  746751E.   1864.5 M   151.0 DEG    2.07 M/SEC    63182.4 M  181.7 DEG       2.70 M/SEC
 27     115 CST   4234119N.  748107E.   2259.0 M   143.1 DEG    2.51 M/SEC    65441.4 M  180.3 DEG       2.69 M/SEC
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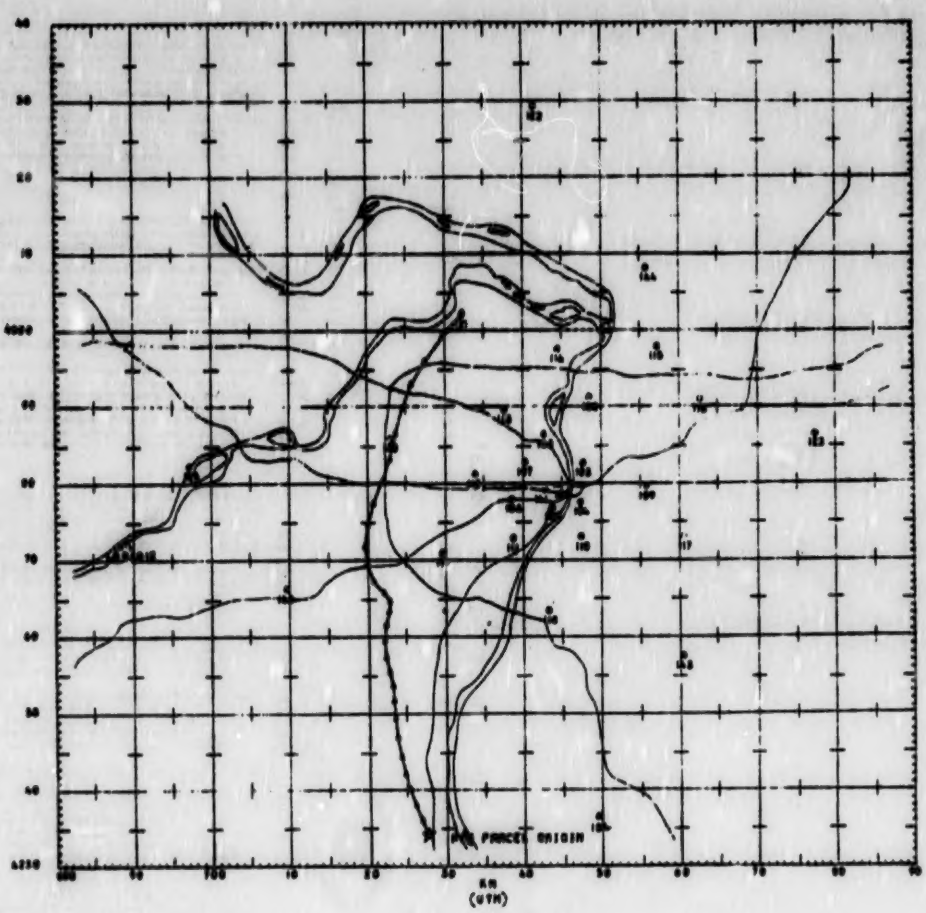

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RAMS NEAR-SFC
TRAJECTORY #16
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 121

STARTING 45 CST 18 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 19 JUL 75    45 CST      END TIME: 18 JUL 75   800 CST
    INITIAL COORDINATES: 4302376N. 732414E.     LOCATION DESCRIPTOR: RAMS STATION NO. 121
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 29

                                                                                     ACCUMULATED DISPLACEMENT
                                            INCREMENTAL DISPLACEMENT          PATH       AZIMUTH          SPEED
STEP   TIME         LOCATION           RADIAL    AZIMUTH      SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    800 CST   4302376N. 732414E.       0 M      0 DEG      0 M/SEC         0 M      0 DEG        0 M/SEC
  1    745 CST   4299338N. 729819E.  3995.0 M  220.5 DEG   4.44 M/SEC    3995.0 M  220.5 DEG     4.44 M/SEC
  2    730 CST   4296090N. 727536E.  3970.2 M  215.1 DEG   4.41 M/SEC    7965.1 M  217.8 DEG     4.43 M/SEC
  3    715 CST   4293048N. 725776E.  3514.5 M  210.1 DEG   3.91 M/SEC   11479.7 M  215.4 DEG     4.25 M/SEC
  4    700 CST   4289901N. 724660E.  3336.7 M  199.4 DEG   3.71 M/SEC   14816.4 M  211.8 DEG     4.12 M/SEC
  5    645 CST   4286625N. 723745E.  3402.9 M  195.7 DEG   3.78 M/SEC   18219.3 M  208.8 DEG     4.05 M/SEC
  6    630 CST   4283264N. 723034E.  3435.1 M  192.0 DEG   3.82 M/SEC   21654.4 M  206.1 DEG     4.01 M/SEC
  7    615 CST   4280277N. 721930E.  3178.1 M  199.9 DEG   3.53 M/SEC   24832.5 M  205.3 DEG     3.94 M/SEC
  8    600 CST   4277484N. 720878E.  2991.1 M  201.0 DEG   3.32 M/SEC   27823.7 M  204.9 DEG     3.86 M/SEC
  9    545 CST   4274639N. 720158E.  2934.8 M  194.2 DEG   3.26 M/SEC   30758.4 M  203.8 DEG     3.80 M/SEC
 10    530 CST   4272006N. 719778E.  2660.9 M  188.2 DEG   2.96 M/SEC   33419.3 M  202.6 DEG     3.71 M/SEC
 11    515 CST   4269591N. 719540E.  2430.6 M  176.2 DEG   2.70 M/SEC   35849.9 M  200.8 DEG     3.62 M/SEC
 12    500 CST   4267352N. 720914E.  2432.2 M  156.4 DEG   2.70 M/SEC   38282.1 M  198.2 DEG     3.54 M/SEC
 13    445 CST   4265883N. 722219E.  1965.0 M  138.4 DEG   2.18 M/SEC   40247.0 M  195.6 DEG     3.44 M/SEC
 14    430 CST   4264896N. 722922E.  1211.4 M  144.6 DEG   1.35 M/SEC   41458.4 M  194.2 DEG     3.29 M/SEC
 15    415 CST   4263529N. 722804E.  1371.4 M  194.9 DEG   1.52 M/SEC   42829.8 M  193.9 DEG     3.17 M/SEC
 16    400 CST   4261752N. 722426E.  1817.5 M  132.0 DEG   2.02 M/SEC   44647.3 M  193.8 DEG     3.10 M/SEC
 17    345 CST   4259655N. 722228E.  2105.7 M  195.4 DEG   2.34 M/SEC   46753.0 M  193.4 DEG     3.06 M/SEC
 18    330 CST   4257601N. 722410E.  2062.2 M  174.9 DEG   2.29 M/SEC   48815.2 M  192.6 DEG     3.01 M/SEC
 19    315 CST   4255736N. 722263E.  1919.1 M  166.3 DEG   2.13 M/SEC   50734.3 M  191.6 DEG     2.97 M/SEC
 20    300 CST   4253959N. 723237E.  1915.3 M  168.7 DEG   2.13 M/SEC   52649.6 M  190.7 DEG     2.92 M/SEC
 21    245 CST   4251962N. 723418E.  1904.8 M  174.6 DEG   2.12 M/SEC   54554.3 M  190.1 DEG     2.89 M/SEC
 22    230 CST   4249745N. 723555E.  2220.6 M  176.5 DEG   2.47 M/SEC   56774.9 M  189.6 DEG     2.87 M/SEC
 23    215 CST   4247219N. 723825E.  2542.1 M  173.9 DEG   2.82 M/SEC   59317.0 M  188.9 DEG     2.87 M/SEC
 24    200 CST   4244739N. 724263E.  2515.5 M  170.0 DEG   2.80 M/SEC   61833.5 M  188.0 DEG     2.86 M/SEC
 25    145 CST   4242450N. 724793E.  2347.6 M  167.2 DEG   2.61 M/SEC   64181.1 M  187.3 DEG     2.85 M/SEC
 26    130 CST   4240378N. 725372E.  2154.4 M  164.1 DEG   2.39 M/SEC   66335.4 M  186.5 DEG     2.83 M/SEC
 27    115 CST   4238442N. 726081E.  2061.3 M  159.9 DEG   2.29 M/SEC   68396.7 M  185.7 DEG     2.81 M/SEC
 28    100 CST   4236531N. 726846E.  2053.7 M  158.1 DEG   2.29 M/SEC   70450.4 M  184.8 DEG     2.80 M/SEC
 29     45 CST   4234588N. 727558E.  2064.4 M  159.9 DEG   2.30 M/SEC   72524.8 M  184.1 DEG     2.78 M/SEC
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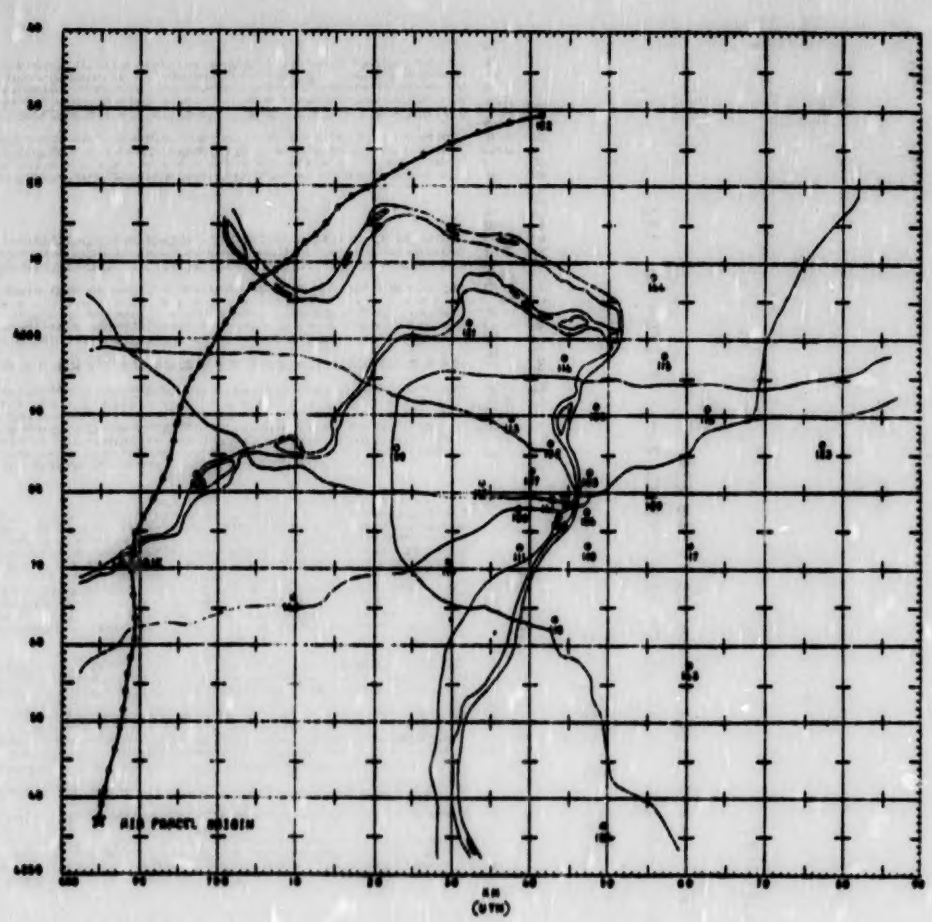

RAMS NEAR-SFC
TRAJECTORY #17
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 122

STARTING 2000 CST 17 JUL 75
ARRIVING 800 CST 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

   START TIME: 17 JUL 75  2000 CST     END TIME: 18 JUL 75   800 CST
   INITIAL COORDINATES: 4329223N. 741631E.    LOCATION DESCRIPTOR: RAMS STATION NO. 122
   TRAJECTORY TYPE: BACKWARD IN TIME
   STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 48

                                                                                      ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT            PATH      AZIMUTH          SPEED
STEP   TIME          LOCATION          RADIAL    AZIMUTH      SPEED          LENGTH   (FROM ORIGIN)  (ALONG PATH)

  0    800 CST   4329223N. 741631E.       0 M       0 DEG      0 M/SEC           0 M       0 DEG        0 M/SEC
  1    745 CST   4328161N. 737364E.  4395.5 M   256.0 DEG   4.88 M/SEC      4396.5 M   256.0 DEG     4.88 M/SEC
  2    730 CST   4326879N. 733380E.  4185.5 M   252.2 DEG   4.65 M/SEC      8581.9 M   254.1 DEG     4.77 M/SEC
  3    715 CST   4325448N. 729705E.  3943.9 M   248.7 DEG   4.38 M/SEC     12525.8 M   252.4 DEG     4.64 M/SEC
  4    700 CST   4323915N. 726398E.  3644.8 M   245.1 DEG   4.05 M/SEC     16170.6 M   250.8 DEG     4.49 M/SEC
  5    645 CST   4322461N. 723632E.  3125.3 M   242.3 DEG   3.47 M/SEC     19295.9 M   249.4 DEG     4.29 M/SEC
  6    630 CST   4321063N. 721262E.  2751.2 M   239.5 DEG   3.06 M/SEC     22047.1 M   248.2 DEG     4.08 M/SEC
  7    615 CST   4319662N. 719160E.  2526.5 M   236.3 DEG   2.81 M/SEC     24573.6 M   247.0 DEG     3.90 M/SEC
  8    600 CST   4318493N. 717311E.  2187.0 M   237.7 DEG   2.43 M/SEC     26760.6 M   246.2 DEG     3.72 M/SEC
  9    545 CST   4317039N. 715459E.  2356.4 M   231.9 DEG   2.62 M/SEC     29117.0 M   245.0 DEG     3.59 M/SEC
 10    530 CST   4314959N. 714015E.  2531.3 M   214.8 DEG   2.81 M/SEC     31648.4 M   242.7 DEG     3.52 M/SEC
 11    515 CST   4313494N. 712676E.  1984.3 M   222.4 DEG   2.20 M/SEC     33632.6 M   241.5 DEG     3.40 M/SEC
 12    500 CST   4312480N. 711289E.  1719.2 M   233.8 DEG   1.91 M/SEC     35351.5 M   241.1 DEG     3.27 M/SEC
 13    445 CST   4311185N. 710191E.  1703.3 M   220.5 DEG   1.89 M/SEC     37054.1 M   240.2 DEG     3.17 M/SEC
 14    430 CST   4309942N. 708946E.  1752.8 M   224.8 DEG   1.95 M/SEC     38806.8 M   239.5 DEG     3.08 M/SEC
 15    415 CST   4308901N. 707580E.  1717.3 M   232.7 DEG   1.91 M/SEC     40524.2 M   239.2 DEG     3.00 M/SEC
 16    400 CST   4307951N. 706060E.  1792.5 M   238.0 DEG   1.99 M/SEC     42316.5 M   239.1 DEG     2.94 M/SEC
 17    345 CST   4306713N. 704533E.  1966.2 M   231.0 DEG   2.18 M/SEC     44282.8 M   238.8 DEG     2.89 M/SEC
 18    330 CST   4305096N. 703161E.  2120.4 M   220.3 DEG   2.36 M/SEC     46403.2 M   237.9 DEG     2.86 M/SEC
 19    315 CST   4303509N. 702051E.  1936.4 M   215.0 DEG   2.15 M/SEC     48339.6 M   237.0 DEG     2.83 M/SEC
 20    300 CST   4302009N. 701138E.  1737.3 M   211.3 DEG   1.93 M/SEC     50096.9 M   236.1 DEG     2.78 M/SEC
 21    245 CST   4300294N. 700208E.  1950.3 M   208.5 DEG   2.17 M/SEC     52047.2 M   235.1 DEG     2.75 M/SEC
 22    230 CST   4298369N. 699080E.  2230.3 M   210.4 DEG   2.48 M/SEC     54277.5 M   234.1 DEG     2.74 M/SEC
 23    215 CST   4296488N. 697879E.  2231.9 M   212.6 DEG   2.48 M/SEC     56509.4 M   233.2 DEG     2.7[illegible] M/SEC
 24    200 CST   4294792N. 696826E.  1996.0 M   211.8 DEG   2.22 M/SEC     58505.4 M   232.5 DEG     2.7[illegible] M/SEC
 25    145 CST   4293061N. 696055E.  1895.9 M   204.0 DEG   2.11 M/SEC     60401.2 M   231.6 DEG     2.6[illegible] M/SEC
 26    130 CST   4291014N. 695405E.  2147.6 M   197.6 DEG   2.39 M/SEC     62548.8 M   230.4 DEG     2.67 M/SEC
 27    115 CST   4288845N. 694879E.  2231.0 M   193.6 DEG   2.48 M/SEC     64779.8 M   229.2 DEG     2.67 M/SEC
 28    100 CST   4286700N. 694556E.  2169.8 M   188.6 DEG   2.41 M/SEC     66949.6 M   227.9 DEG     2.66 M/SEC
 29     45 CST   4284307N. 694036E.  2448.6 M   192.3 DEG   2.72 M/SEC     69398.1 M   226.7 DEG     2.66 M/SEC
 30     30 CST   4281756N. 693154E.  2699.5 M   199.1 DEG   3.00 M/SEC     72097.6 M   225.6 DEG     2.67 M/SEC
 31     15 CST   4279132N. 691571E.  2894.9 M   205.0 DEG   3.22 M/SEC     74992.5 M   224.8 DEG     2.69 M/SEC
 32      0 CST   4276698N. 690590E.  2779.1 M   208.9 DEG   3.09 M/SEC     77771.6 M   224.2 DEG     2.70 M/SEC
 33   2345 CST   4274560N. 689557E.  2374.5 M   205.8 DEG   2.64 M/SEC     80146.1 M   223.6 DEG     2.70 M/SEC
 34   2330 CST   4272341N. 689153E.  2255.6 M   190.3 DEG   2.51 M/SEC     82401.6 M   222.7 DEG     2.69 M/SEC
 35   2315 CST   4269798N. 689179E.  2542.9 M   179.4 DEG   2.83 M/SEC     84944.5 M   221.4 DEG     2.70 M/SEC
 36   2300 CST   4265710N. 689335E.  3091.5 M   177.1 DEG   3.44 M/SEC     88036.0 M   219.9 DEG     2.72 M/SEC
 37   2245 CST   4263664N. 689575E.  3055.9 M   175.5 DEG   3.40 M/SEC     91091.9 M   218.5 DEG     2.74 M/SEC
 38   2230 CST   4260968N. 689450E.  2696.8 M   181.8 DEG   3.00 M/SEC     93788.7 M   217.4 DEG     2.74 M/SEC
 39   2215 CST   4258511N. 688930E.  2507.9 M   191.5 DEG   2.79 M/SEC     96296.5 M   216.7 DEG     2.74 M/SEC
 40   2200 CST   4256367N. 688554E.  2188.1 M   191.5 DEG   2.43 M/SEC     98484.6 M   216.1 DEG     2.74 M/SEC
 41   2145 CST   4254186N. 688339E.  2190.9 M   185.6 DEG   2.43 M/SEC    100675.4 M   215.4 DEG     2.73 M/SEC
 42   2130 CST   4251816N. 688073E.  2384.9 M   186.4 DEG   2.65 M/SEC    103060.3 M   214.7 DEG     2.73 M/SEC
 43   2115 CST   4249270N. 687664E.  2579.0 M   189.1 DEG   2.87 M/SEC    105639.3 M   214.0 DEG     2.73 M/SEC
 44   2100 CST   4246558N. 687014E.  2788.5 M   193.5 DEG   3.10 M/SEC    108427.8 M   213.5 DEG     2.74 M/SEC
 45   2045 CST   4243798N. 686258E.  2861.7 M   195.3 DEG   3.18 M/SEC    111289.4 M   213.0 DEG     2.75 M/SEC
 46   2030 CST   4241403N. 685659E.  2459.1 M   193.1 DEG   2.73 M/SEC    113748.5 M   212.5 DEG     2.75 M/SEC
 47   2015 CST   4239422N. 685228E.  2015.5 M   190.6 DEG   2.24 M/SEC    115764.0 M   212.1 DEG     2.74 M/SEC
 48   2000 CST   4237360N. 684459E.  2094.9 M   190.1 DEG   2.33 M/SEC    117858.9 M   211.7 DEG     2.73 M/SEC
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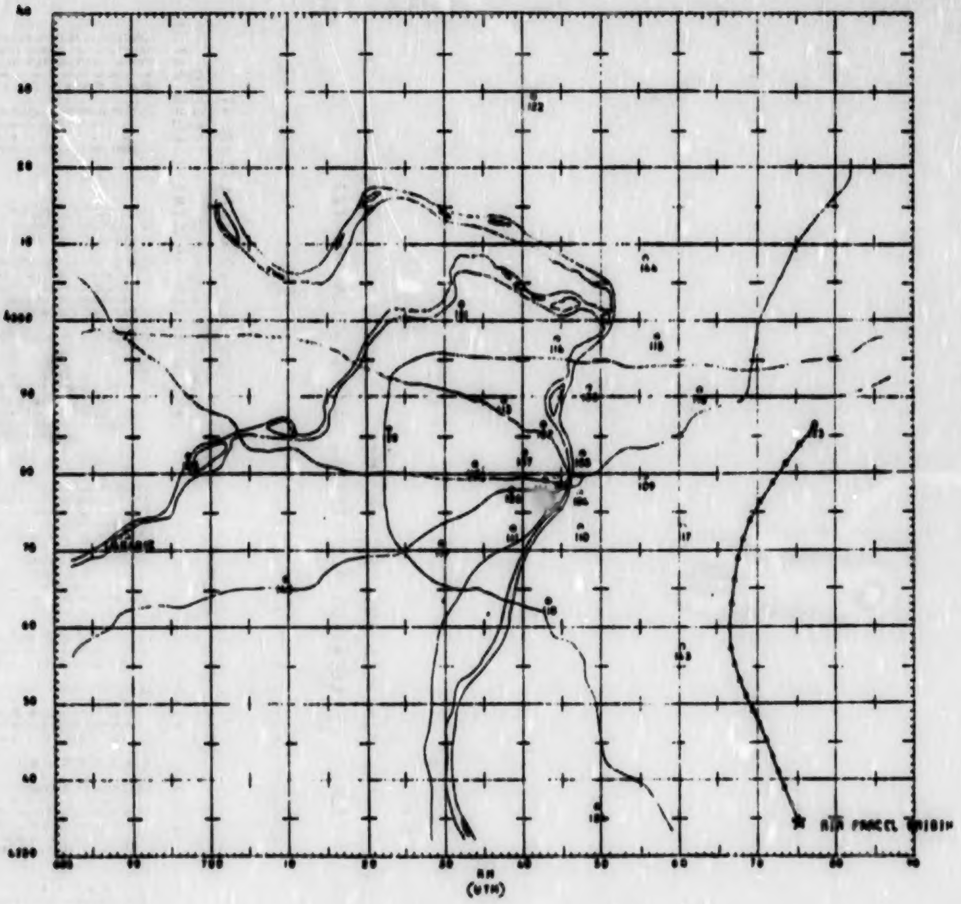
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(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #18
ST. LOUIS. MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 123

STARTING 2300 CDT 18 JUL 75
ARRIVING 800 CDT 18 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 18 JUL 75   230 CST     END TIME: 18 JUL 75   800 CST

    INITIAL COORDINATES: 4286378N. 7773205E.     LOCATION DESCRIPTOR: RAMS STATION NO. 123

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN         NUMBER OF STEPS: 22

                                                                                   ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT            PATH        AZIMUTH          SPEED
STEP   TIME          LOCATION          RADIAL     AZIMUTH       SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    800 CST   4286378N. 7773205E.       0 M       0 DEG       0 M/SEC          0 M       0 DEG        0 M/SEC
  1    745 CST   4283978N. 7754545E.  3039.6 M   217.9 DEG    3.38 M/SEC     3039.6 M   217.9 DEG     3.38 M/SEC
  2    730 CST   4281517N. 7736455E.  3053.9 M   216.3 DEG    3.39 M/SEC     6093.5 M   217.1 DEG     3.39 M/SEC
  3    715 CST   4279062N. 7717935E.  2959.4 M   213.9 DEG    3.29 M/SEC     9052.9 M   216.1 DEG     3.35 M/SEC
  4    700 CST   4276598N. 7704405E.  2922.7 M   212.1 DEG    3.25 M/SEC    11975.6 M   215.1 DEG     3.33 M/SEC
  5    645 CST   4274201N. 7691375E.  2717.9 M   208.6 DEG    3.02 M/SEC    14693.5 M   213.9 DEG     3.27 M/SEC
  6    630 CST   4271779N. 7682285E.  2565.4 M   200.5 DEG    2.85 M/SEC    17258.9 M   211.9 DEG     3.20 M/SEC
  7    615 CST   4269247N. 7675985E.  2530.4 M   194.1 DEG    2.72 M/SEC    19889.3 M   209.6 DEG     3.16 M/SEC
  8    600 CST   4266415N. 7671355E.  2865.5 M   189.3 DEG    3.18 M/SEC    22754.8 M   207.0 DEG     3.16 M/SEC
  9    545 CST   4263735N. 7667985E.  3043.7 M   186.6 DEG    3.38 M/SEC    25798.5 M   204.6 DEG     3.18 M/SEC
 10    530 CST   4260375N. 7665825E.  3022.8 M   193.9 DEG    3.36 M/SEC    28821.3 M   202.4 DEG     3.20 M/SEC
 11    515 CST   4257658N. 7667035E.  2724.1 M   177.5 DEG    3.03 M/SEC    31545.4 M   200.3 DEG     3.19 M/SEC
 12    500 CST   4255490N. 7671785E.  2220.0 M   167.6 DEG    2.47 M/SEC    33765.4 M   198.2 DEG     3.13 M/SEC
 13    445 CST   4253432N. 7673475E.  2159.5 M   161.5 DEG    2.41 M/SEC    35924.9 M   196.0 DEG     3.07 M/SEC
 14    430 CST   4251382N. 7684505E.  2134.9 M   159.1 DEG    2.44 M/SEC    38129.8 M   193.9 DEG     3.03 M/SEC
 15    415 CST   4249542N. 7694955E.  2020.4 M   155.6 DEG    2.24 M/SEC    40150.2 M   192.0 DEG     2.97 M/SEC
 16    400 CST   4247496N. 7703545E.  2039.8 M   154.8 DEG    2.27 M/SEC    42190.0 M   190.2 DEG     2.93 M/SEC
 17    345 CST   4245593N. 7711975E.  2173.5 M   157.2 DEG    2.42 M/SEC    44363.7 M   188.6 DEG     2.90 M/SEC
 18    330 CST   4243622N. 7719565E.  2205.5 M   159.9 DEG    2.45 M/SEC    46569.1 M   187.1 DEG     2.87 M/SEC
 19    315 CST   4241537N. 7726655E.  2202.8 M   161.2 DEG    2.45 M/SEC    48771.9 M   185.9 DEG     2.85 M/SEC
 20    300 CST   4239472N. 7734715E.  2216.2 M   158.7 DEG    2.46 M/SEC    50988.1 M   184.7 DEG     2.83 M/SEC
 21    245 CST   4237367N. 7743375E.  2276.4 M   157.6 DEG    2.53 M/SEC    53264.5 M   183.5 DEG     2.82 M/SEC
 22    230 CST   4234972N. 7752065E.  2547.1 M   160.1 DEG    2.83 M/SEC    55811.6 M   182.4 DEG     2.82 M/SEC
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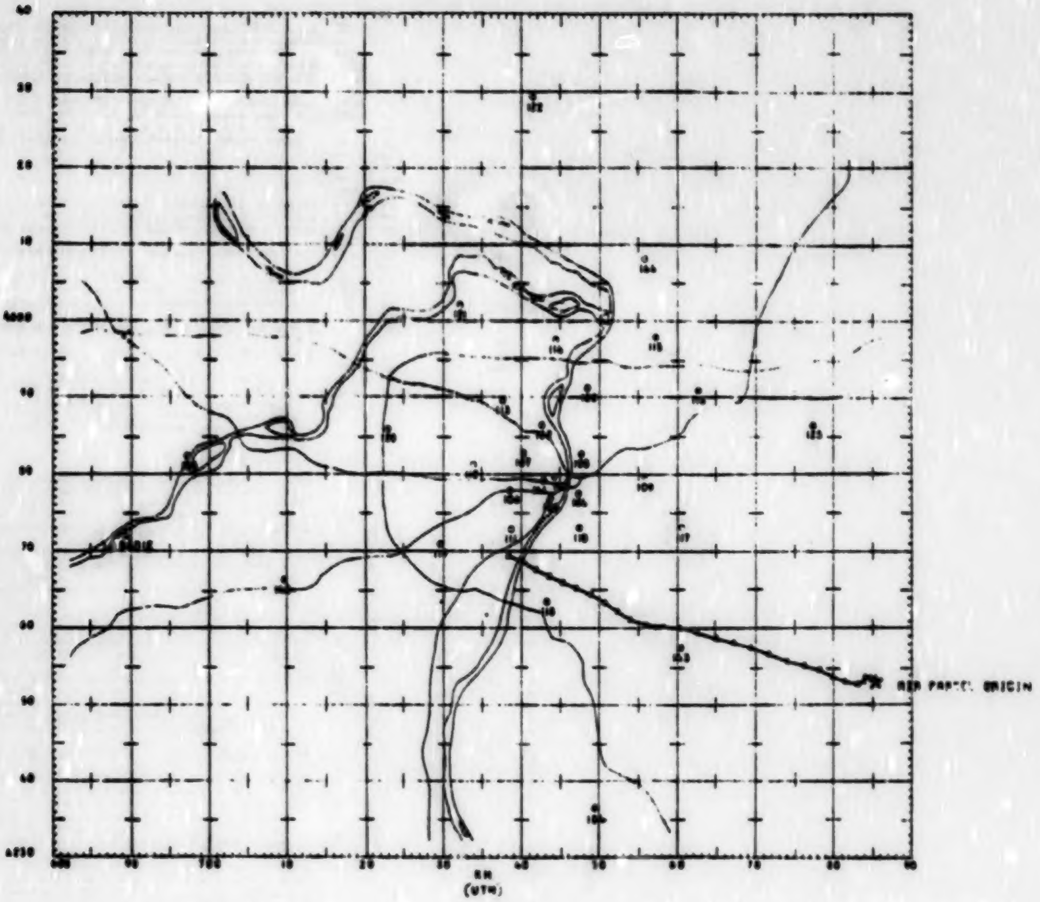
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #19
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1215 CST 22 JUL 75
ARRIVING 1300 CST 22 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  1215 CST      END TIME: 22 JUL 75  1900 CST
    INITIAL COORDINATES: 4269380N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 27

                                                                                          ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT              PATH        AZIMUTH          SPEED
 STEP    TIME          LOCATION            RADIAL    AZIMUTH      SPEED            LENGTH   (FROM ORIGIN)  (ALONG PATH)

   0    1900 CST   4269380N.  738500E.        0 M      0 DEG      0 M/SEC             0 M       0 DEG        0 M/SEC
   1    1845 CST   4268555N.  740307E.   1986.4 M  114.5 DEG   2.21 M/SEC        1986.4 M   114.5 DEG     2.21 M/SEC
   2    1830 CST   4267618N.  742050E.   1979.7 M  118.3 DEG   2.20 M/SEC        3966.1 M   115.4 DEG     2.20 M/SEC
   3    1815 CST   4266745N.  743742E.   1903.7 M  117.3 DEG   2.12 M/SEC        5869.8 M   116.7 DEG     2.17 M/SEC
   4    1800 CST   4265939N.  745446E.   1884.2 M  115.3 DEG   2.09 M/SEC        7754.0 M   116.3 DEG     2.15 M/SEC
   5    1745 CST   4265253N.  747322E.   1904.5 M  111.1 DEG   2.12 M/SEC        9658.5 M   115.3 DEG     2.15 M/SEC
   6    1730 CST   4264432N.  749093E.   2031.7 M  113.9 DEG   2.26 M/SEC       11690.2 M   115.1 DEG     2.16 M/SEC
   7    1715 CST   4263346N.  750972E.   2094.5 M  121.2 DEG   2.33 M/SEC       13784.7 M   116.0 DEG     2.19 M/SEC
   8    1700 CST   4262235N.  752457E.   1935.8 M  125.0 DEG   2.15 M/SEC       15720.5 M   117.1 DEG     2.18 M/SEC
   9    1645 CST   4261164N.  754098E.   1963.3 M  123.1 DEG   2.18 M/SEC       17680.9 M   117.8 DEG     2.18 M/SEC
  10    1630 CST   4260545N.  756090E.   2085.8 M  107.3 DEG   2.32 M/SEC       19766.5 M   116.7 DEG     2.20 M/SEC
  11    1615 CST   4260366N.  758336E.   2253.5 M   94.6 DEG   2.50 M/SEC       22017.0 M   114.4 DEG     2.22 M/SEC
  12    1600 CST   4260086N.  760442E.   2127.0 M   97.6 DEG   2.36 M/SEC       24144.0 M   113.0 DEG     2.24 M/SEC
  13    1545 CST   4259488N.  762640E.   2277.7 M  105.2 DEG   2.53 M/SEC       26421.7 M   112.3 DEG     2.26 M/SEC
  14    1530 CST   4258804N.  765072E.   2526.2 M  105.7 DEG   2.81 M/SEC       28948.0 M   111.7 DEG     2.30 M/SEC
  15    1515 CST   4258246N.  767317E.   2313.4 M  104.0 DEG   2.57 M/SEC       31261.4 M   111.1 DEG     2.32 M/SEC
  16    1500 CST   4257665N.  769452E.   2212.6 M  105.2 DEG   2.46 M/SEC       33474.0 M   110.7 DEG     2.32 M/SEC
  17    1445 CST   4256792N.  771781E.   2486.8 M  110.5 DEG   2.76 M/SEC       35960.9 M   110.7 DEG     2.35 M/SEC
  18    1430 CST   4255835N.  774110E.   2499.4 M  111.3 DEG   2.78 M/SEC       38460.2 M   110.8 DEG     2.37 M/SEC
  19    1415 CST   4255237N.  776316E.   2272.9 M  103.9 DEG   2.53 M/SEC       40733.1 M   110.4 DEG     2.38 M/SEC
  20    1400 CST   4254906N.  778306E.   2051.2 M  104.9 DEG   2.28 M/SEC       42784.3 M   110.1 DEG     2.38 M/SEC
  21    1345 CST   4253087N.  779960E.   1854.8 M  116.3 DEG   2.06 M/SEC       44639.1 M   110.4 DEG     2.36 M/SEC
  22    1330 CST   4253295N.  781594E.   1774.6 M  113.0 DEG   1.97 M/SEC       46413.6 M   110.5 DEG     2.34 M/SEC
  23    1315 CST   4252997N.  783141E.   1574.9 M  100.9 DEG   1.75 M/SEC       47988.5 M   110.2 DEG     2.32 M/SEC
  24    1300 CST   4253326N.  783910E.    835.6 M   66.8 DEG   0.93 M/SEC       48825.1 M   109.5 DEG     2.26 M/SEC
  25    1245 CST   4253985N.  784111E.    594.2 M   19.8 DEG   0.66 M/SEC       49419.4 M   108.8 DEG     2.20 M/SEC
  26    1230 CST   4253758N.  784763E.    664.8 M  101.0 DEG   0.74 M/SEC       50084.1 M   108.7 DEG     2.14 M/SEC
  27    1215 CST   4253264N.  785375E.    786.2 M  128.9 DEG   0.87 M/SEC       50870.3 M   109.0 DEG     2.09 M/SEC
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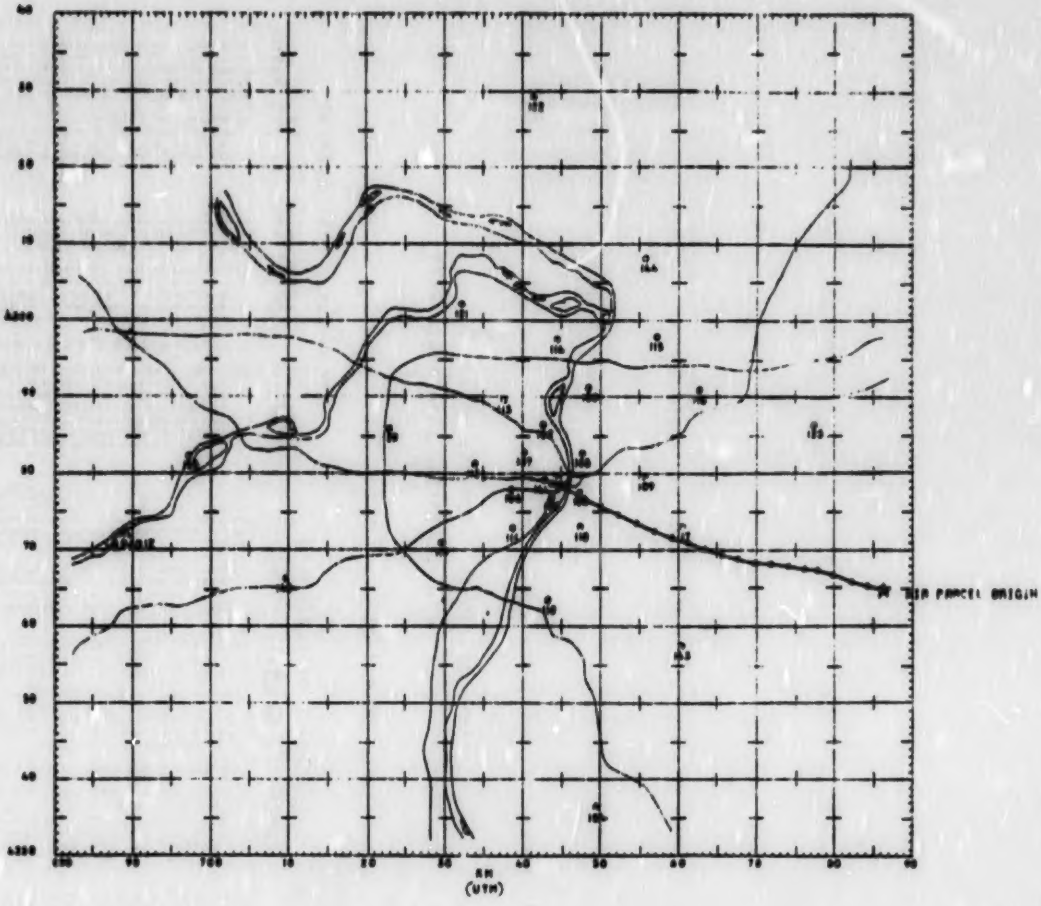
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #20
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1400 CDT 22 JUL 75
ARRIVING 1900 CDT 22 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  1400 CST      END TIME: 22 JUL 75  1900 CST

    INITIAL COORDINATES: 4278750N, 743880E.      LOCATION DESCRIPTOR: 14TH AND MARKET

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 20

                                                                             ACCUMULATED DISPLACEMENT
                                             INCREMENTAL DISPLACEMENT      PATH       AZIMUTH        SPEED
STEP   TIME         LOCATION          RADIAL     AZIMUTH      SPEED       LENGTH   (FROM ORIGIN)  (ALONG PATH)

  0    1900 CST   4278750N.  743880E.        0 M      0 DEG      0 M/SEC         0 M      0 DEG      0 M/SEC
  1    1845 CST   4277988N.  745973E.   2228.5 M  110.0 DEG   2.48 M/SEC    2228.5 M  110.0 DEG   2.48 M/SEC
  2    1830 CST   4276862N.  748092E.   2399.7 M  118.0 DEG   2.67 M/SEC    4627.2 M  114.1 DEG   2.57 M/SEC
  3    1815 CST   4275753N.  750246E.   2422.7 M  117.2 DEG   2.69 M/SEC    7049.9 M  115.2 DEG   2.61 M/SEC
  4    1800 CST   4274731N.  752464E.   2442.2 M  114.8 DEG   2.71 M/SEC    9492.1 M  115.1 DEG   2.64 M/SEC
  5    1745 CST   4273643N.  754745E.   2527.0 M  115.5 DEG   2.81 M/SEC   12019.0 M  115.2 DEG   2.67 M/SEC
  6    1730 CST   4272592N.  757070E.   2551.7 M  114.3 DEG   2.84 M/SEC   14570.7 M  115.0 DEG   2.70 M/SEC
  7    1715 CST   4271763N.  759278E.   2358.7 M  110.6 DEG   2.62 M/SEC   16929.4 M  114.4 DEG   2.69 M/SEC
  8    1700 CST   4271084N.  761362E.   2182.1 M  108.1 DEG   2.42 M/SEC   19111.3 M  113.7 DEG   2.65 M/SEC
  9    1645 CST   4270293N.  763515E.   2303.0 M  110.1 DEG   2.56 M/SEC   21414.5 M  113.3 DEG   2.64 M/SEC
 10    1630 CST   4269557N.  765735E.   2340.1 M  108.4 DEG   2.60 M/SEC   23754.6 M  112.8 DEG   2.64 M/SEC
 11    1615 CST   4269034N.  767803E.   2133.2 M  104.2 DEG   2.37 M/SEC   25887.8 M  112.1 DEG   2.61 M/SEC
 12    1600 CST   4268528N.  769859E.   2116.7 M  103.8 DEG   2.35 M/SEC   28004.5 M  111.5 DEG   2.59 M/SEC
 13    1545 CST   4268387N.  771992E.   2138.0 M   93.7 DEG   2.38 M/SEC   30142.5 M  110.2 DEG   2.58 M/SEC
 14    1530 CST   4268108N.  774246E.   2271.4 M   97.1 DEG   2.52 M/SEC   32413.9 M  109.3 DEG   2.57 M/SEC
 15    1515 CST   4267793N.  776254E.   2031.9 M   98.9 DEG   2.26 M/SEC   34445.8 M  108.7 DEG   2.55 M/SEC
 16    1500 CST   4267573N.  777943E.   1703.6 M   97.4 DEG   1.89 M/SEC   36149.4 M  108.2 DEG   2.51 M/SEC
 17    1445 CST   4267003N.  779944E.   2081.1 M  105.9 DEG   2.31 M/SEC   38230.5 M  108.0 DEG   2.50 M/SEC
 18    1430 CST   4266117N.  782297E.   2513.7 M  110.6 DEG   2.79 M/SEC   40744.3 M  108.2 DEG   2.52 M/SEC
 19    1415 CST   4265573N.  784301E.   2076.5 M  105.2 DEG   2.31 M/SEC   42820.9 M  108.1 DEG   2.50 M/SEC
 20    1400 CST   4265054N.  786294E.   2059.3 M  104.5 DEG   2.29 M/SEC   44880.2 M  107.9 DEG   2.49 M/SEC
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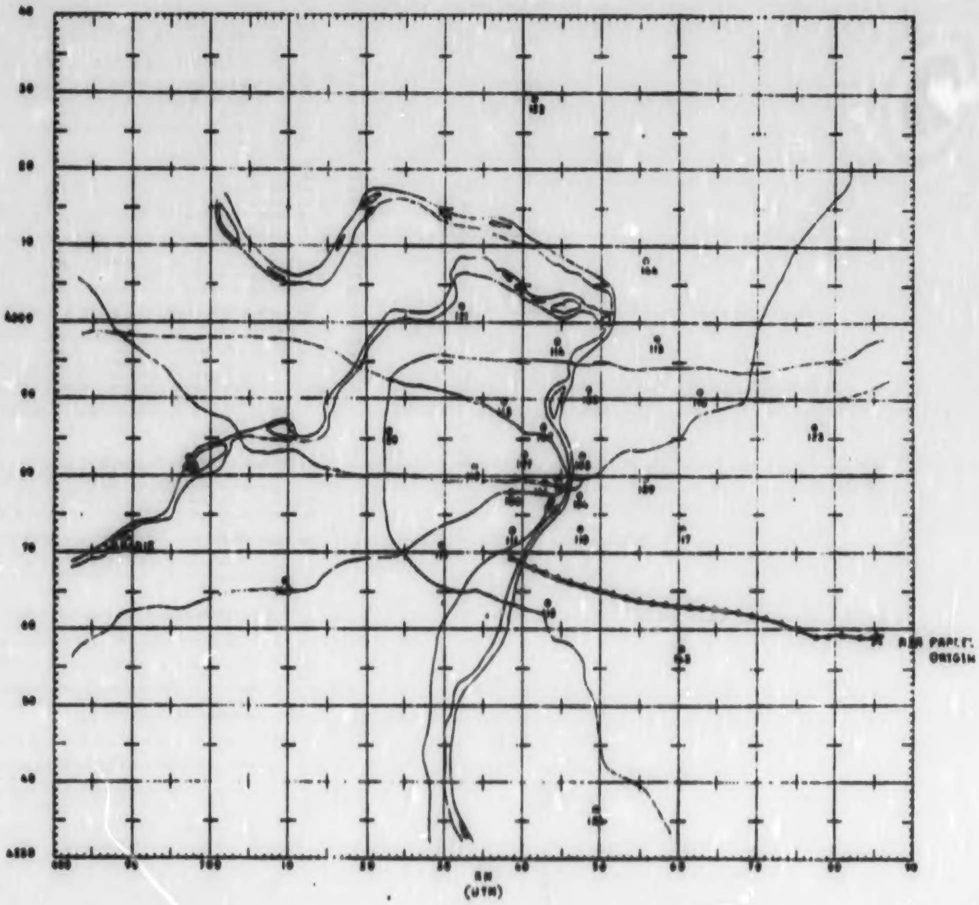

RAMS NEAR-SFC
TRAJECTORY #21
ST. LOUIS. MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1615 CST 22 JUL 75
ARRIVING 2300 CST 22 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  1615 CST     END TIME: 22 JUL 75  2300 CST
    INITIAL COORDINATES: 4269380N. 739500E.     LOCATION DESCRIPTOR: BROADWAY AND MURCK
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 27

                                                                                 ACCUMULATED DISPLACEMENT
                                            INCREMENTAL DISPLACEMENT
                                                                          PATH       AZIMUTH         SPEED
STEP   TIME          LOCATION           RADIAL     AZIMUTH     SPEED      LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2300 CST   4269380N.  739500E.        0 M      0 DEG      0 M/SEC        0 M      0 DEG        0 M/SEC
  1    2245 CST   4269512N.  740017E.   1701.1 M  116.8 DEG   1.89 M/SEC   1701.1 M  116.8 DEG     1.89 M/SEC
  2    2230 CST   4267990N.  741492E.   1591.7 M  113.0 DEG   1.77 M/SEC   3292.7 M  115.0 DEG     1.83 M/SEC
  3    2215 CST   4267317N.  742932E.   1599.1 M  114.9 DEG   1.78 M/SEC   4890.9 M  115.0 DEG     1.81 M/SEC
  4    2200 CST   4266606N.  744449E.   1654.6 M  113.5 DEG   1.84 M/SEC   6545.5 M  114.6 DEG     1.82 M/SEC
  5    2145 CST   4266138N.  746096E.   1726.7 M  107.5 DEG   1.92 M/SEC   8272.1 M  113.1 DEG     1.84 M/SEC
  6    2130 CST   4265534N.  747975E.   1848.6 M  105.7 DEG   2.05 M/SEC  10120.7 M  111.8 DEG     1.87 M/SEC
  7    2115 CST   4265131N.  749702E.   1895.3 M  105.4 DEG   2.11 M/SEC  12016.0 M  110.8 DEG     1.91 M/SEC
  8    2100 CST   4264655N.  751501E.   1860.5 M  104.7 DEG   2.07 M/SEC  13876.4 M  110.0 DEG     1.93 M/SEC
  9    2045 CST   4264185N.  753191E.   1755.2 M  105.7 DEG   1.95 M/SEC  15631.7 M  109.5 DEG     1.93 M/SEC
 10    2030 CST   4263806N.  754871E.   1721.7 M  102.7 DEG   1.91 M/SEC  17353.3 M  108.8 DEG     1.93 M/SEC
 11    2015 CST   4263542N.  756447E.   1795.2 M   98.5 DEG   1.99 M/SEC  19148.5 M  107.8 DEG     1.93 M/SEC
 12    2000 CST   4263316N.  758292E.   1660.6 M   97.9 DEG   1.85 M/SEC  20809.2 M  107.0 DEG     1.93 M/SEC
 13    1945 CST   4263133N.  759730E.   1509.8 M   96.9 DEG   1.68 M/SEC  22318.0 M  106.4 DEG     1.91 M/SEC
 14    1930 CST   4262578N.  761352E.   1569.7 M   95.7 DEG   1.74 M/SEC  23887.7 M  105.6 DEG     1.90 M/SEC
 15    1915 CST   4262804N.  762398E.   1648.8 M   92.9 DEG   1.83 M/SEC  25536.5 M  104.8 DEG     1.89 M/SEC
 16    1900 CST   4262305N.  764493E.   1496.9 M   93.3 DEG   1.66 M/SEC  27033.4 M  104.2 DEG     1.88 M/SEC
 17    1845 CST   4262564N.  765927E.   1435.5 M   99.8 DEG   1.59 M/SEC  28468.9 M  104.0 DEG     1.86 M/SEC
 18    1830 CST   4262270N.  767534E.   1653.2 M  100.3 DEG   1.84 M/SEC  30122.1 M  103.8 DEG     1.86 M/SEC
 19    1815 CST   4261934N.  769261E.   1759.0 M  101.0 DEG   1.95 M/SEC  31881.1 M  103.6 DEG     1.86 M/SEC
 20    1800 CST   4261519N.  771010E.   1797.9 M  103.3 DEG   2.00 M/SEC  33679.0 M  103.6 DEG     1.87 M/SEC
 21    1745 CST   4260912N.  773038E.   2117.2 M  106.7 DEG   2.35 M/SEC  35796.2 M  103.8 DEG     1.89 M/SEC
 22    1730 CST   4260032N.  775311E.   2435.5 M  111.0 DEG   2.71 M/SEC  38231.7 M  104.2 DEG     1.93 M/SEC
 23    1715 CST   4259092N.  777446E.   2334.4 M  113.9 DEG   2.59 M/SEC  40566.0 M  104.8 DEG     1.96 M/SEC
 24    1700 CST   4259168N.  779033E.   1593.6 M   97.3 DEG   1.77 M/SEC  42159.6 M  104.1 DEG     1.95 M/SEC
 25    1645 CST   4259397N.  780770E.   1751.9 M   92.5 DEG   1.95 M/SEC  43907.5 M  103.3 DEG     1.95 M/SEC
 26    1630 CST   4259042N.  783017E.   2274.4 M   99.0 DEG   2.53 M/SEC  46181.9 M  103.1 DEG     1.97 M/SEC
 27    1615 CST   4258980N.  785145E.   2129.6 M   91.7 DEG   2.37 M/SEC  48311.5 M  102.6 DEG     1.99 M/SEC
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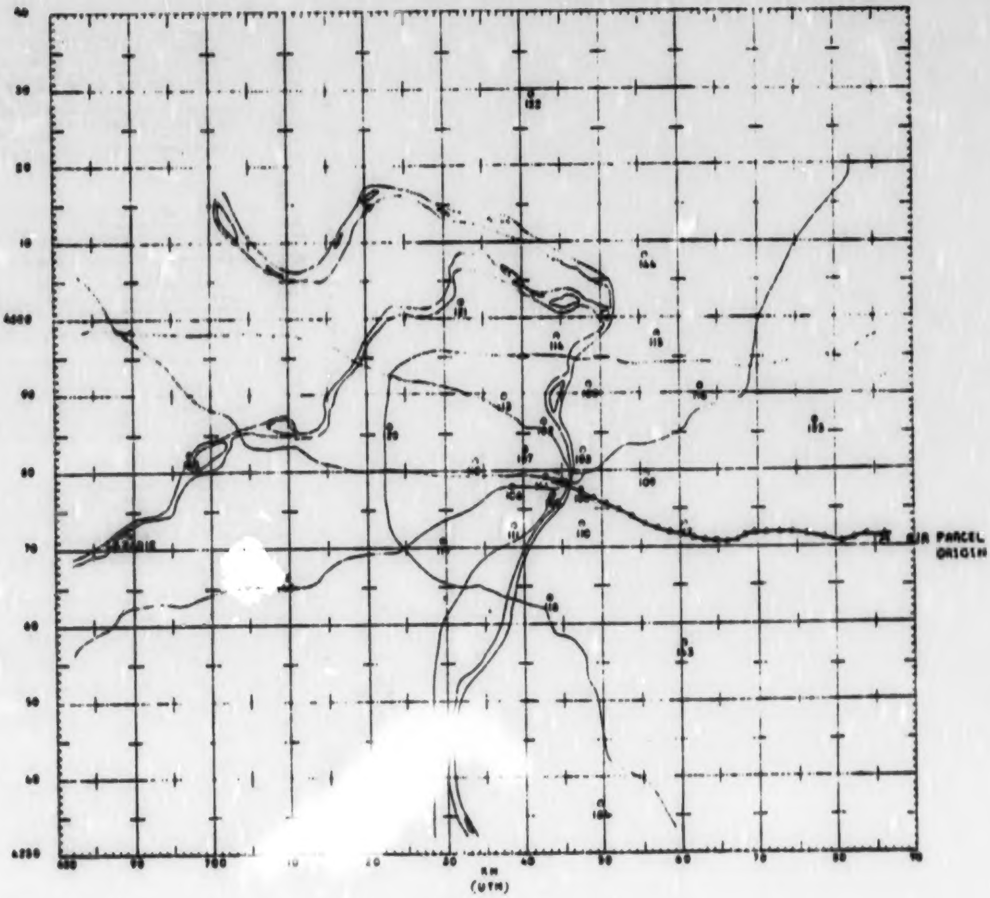
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(UTM)
AIR PARCEL
ORIGIN

RAMS NEAR-SFC
TRAJECTORY #22
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1630 CST 22 JUL 75
ARRIVING 2300 CST 22 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SAMPLING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  1630 CST      END TIME: 22 JUL 75  2300 CST
    INITIAL COORDINATES: 4278750N. 7438300E.     LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 26

                                                                              ACCUMULATED DISPLACEMENT
                                             INCREMENTAL DISPLACEMENT        PATH      AZIMUTH         SPEED
STEP   TIME          LOCATION           RADIAL    AZIMUTH      SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2300 CST   4278750N. 7438300E.        0 M     0 DEG      0 M/SEC          0 M     0 DEG      0 M/SEC
  1    2245 CST   4278164N. 7455793E.   1796.6 M  109.0 DEG   2.00 M/SEC    1796.6 M  109.0 DEG   2.00 M/SEC
  2    2230 CST   4277350N. 7473155E.   1918.1 M  115.1 DEG   2.13 M/SEC    3714.7 M  112.2 DEG   2.06 M/SEC
  3    2215 CST   4276456N. 7489523E.   1848.8 M  118.6 DEG   2.05 M/SEC    5563.5 M  114.3 DEG   2.06 M/SEC
  4    2200 CST   4275724N. 7505165E.   1742.9 M  115.2 DEG   1.94 M/SEC    7306.4 M  114.5 DEG   2.03 M/SEC
  5    2145 CST   4275024N. 7521560E.   1778.0 M  113.2 DEG   1.98 M/SEC    9084.4 M  114.2 DEG   2.02 M/SEC
  6    2130 CST   4274095N. 7538145E.   1906.1 M  119.2 DEG   2.12 M/SEC   10990.5 M  115.1 DEG   2.04 M/SEC
  7    2115 CST   4273148N. 7554665E.   1904.2 M  119.8 DEG   2.12 M/SEC   12894.7 M  115.3 DEG   2.05 M/SEC
  8    2100 CST   4272542N. 7570785E.   1722.1 M  110.6 DEG   1.91 M/SEC   14616.8 M  115.2 DEG   2.03 M/SEC
  9    2045 CST   4272128N. 7586288E.   1605.2 M  105.0 DEG   1.78 M/SEC   16222.0 M  114.2 DEG   2.00 M/SEC
 10    2030 CST   4271736N. 7601225E.   1543.2 M  104.6 DEG   1.71 M/SEC   17765.2 M  113.4 DEG   1.97 M/SEC
 11    2015 CST   4271338N. 7616155E.   1545.7 M  104.9 DEG   1.72 M/SEC   19310.9 M  112.7 DEG   1.95 M/SEC
 12    2000 CST   4271049N. 7630875E.   1499.6 M  101.1 DEG   1.67 M/SEC   20810.5 M  111.8 DEG   1.93 M/SEC
 13    1945 CST   4270964N. 7644936E.   1414.2 M   95.9 DEG   1.57 M/SEC   22224.7 M  110.8 DEG   1.90 M/SEC
 14    1930 CST   4270763N. 7659465E.   1459.0 M   95.5 DEG   1.62 M/SEC   23682.7 M  109.9 DEG   1.88 M/SEC
 15    1915 CST   4270903N. 7672235E.   1314.9 M   79.9 DEG   1.46 M/SEC   24997.6 M  108.4 DEG   1.85 M/SEC
 16    1900 CST   4271619N. 7682135E.   1162.7 M   57.4 DEG   1.29 M/SEC   26160.3 M  106.3 DEG   1.82 M/SEC
 17    1845 CST   4271924N. 7694155E.   1234.9 M   75.6 DEG   1.37 M/SEC   27395.2 M  105.0 DEG   1.79 M/SEC
 18    1830 CST   4271965N. 7709935E.   1578.8 M   88.4 DEG   1.75 M/SEC   28973.9 M  104.0 DEG   1.79 M/SEC
 19    1815 CST   4272098N. 7726435E.   1641.8 M   88.6 DEG   1.82 M/SEC   30615.7 M  103.2 DEG   1.79 M/SEC
 20    1800 CST   4271985N. 7742905E.   1655.5 M   90.8 DEG   1.84 M/SEC   32271.2 M  102.5 DEG   1.79 M/SEC
 21    1745 CST   4271742N. 7761845E.   1910.1 M   97.3 DEG   2.12 M/SEC   34181.3 M  102.2 DEG   1.81 M/SEC
 22    1730 CST   4271245N. 7783715E.   2242.2 M  102.8 DEG   2.49 M/SEC   36423.5 M  102.3 DEG   1.84 M/SEC
 23    1715 CST   4270720N. 7805985E.   2286.2 M  103.0 DEG   2.54 M/SEC   38709.6 M  102.3 DEG   1.87 M/SEC
 24    1700 CST   4271211N. 7821605E.   1635.0 M   72.9 DEG   1.82 M/SEC   40344.7 M  101.1 DEG   1.87 M/SEC
 25    1645 CST   4271638N. 7837695E.   1664.4 M   75.1 DEG   1.85 M/SEC   42009.1 M  100.1 DEG   1.87 M/SEC
 26    1630 CST   4271307N. 7860025E.   2257.8 M   98.4 DEG   2.51 M/SEC   44267.0 M  100.0 DEG   1.89 M/SEC
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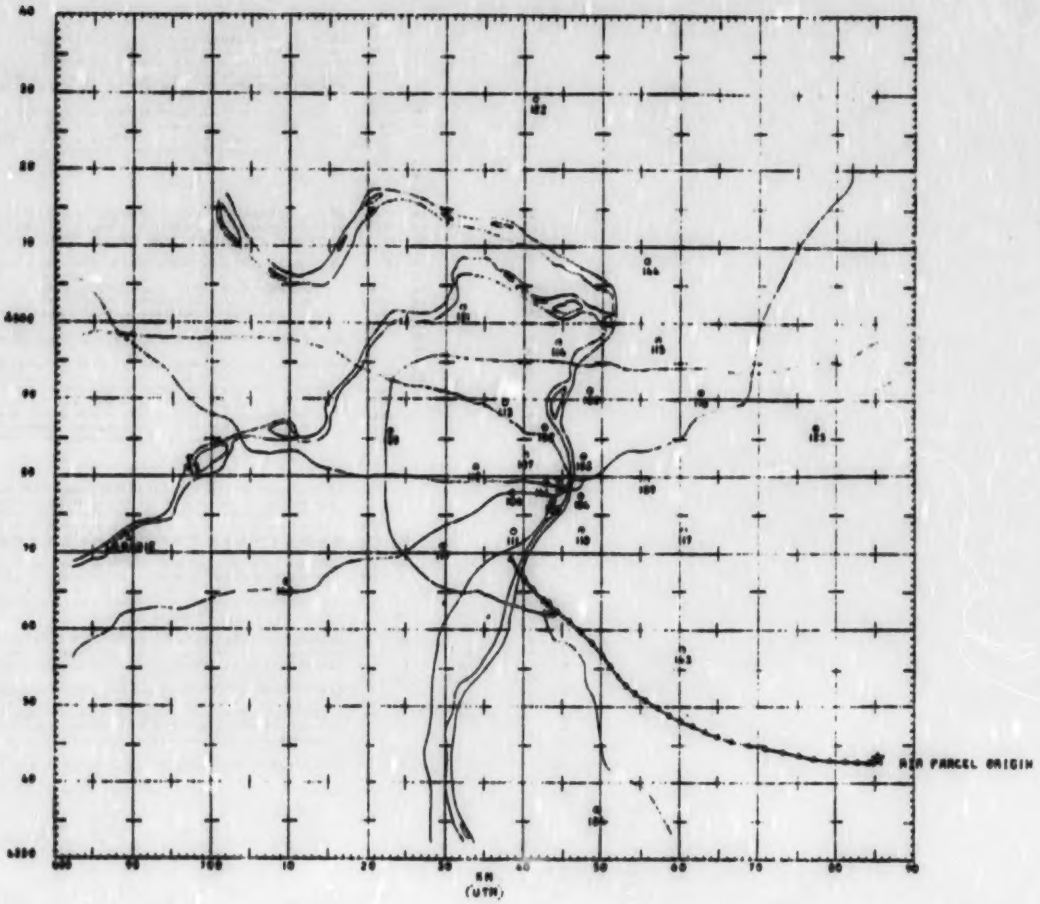

RAMS NEAR-SFC
TRAJECTORY #23
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1915 CDT 22 JUL 75
ARRIVING 300 CDT 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  1915 CST      END TIME: 23 JUL 75   300 CST

    INITIAL COORDINATES: 4269380N. 738500E.     LOCATION DESCRIPTOR: BROADWAY AND MURCK

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 31

                                                                                     ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT
                                                                                PATH       AZIMUTH          SPEED
STEP   TIME         LOCATION              RADIAL    AZIMUTH      SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0     300  CST   4269380N.  738500E.        0 M       0 DEG      0 M/SEC           0 M      0 DEG       0 M/SEC
  1     245  CST   4267876N.  739356E.   1729.9 M  150.3 DEG   1.92 M/SEC      1729.9 M  150.3 DEG    1.92 M/SEC
  2     230  CST   4266613N.  740228E.   1533.4 M  145.5 DEG   1.70 M/SEC      3263.3 M  148.0 DEG    1.81 M/SEC
  3     215  CST   4265347N.  741295E.   1658.0 M  139.8 DEG   1.84 M/SEC      4921.3 M  145.3 DEG    1.82 M/SEC
  4     200  CST   4263939N.  742698E.   1987.9 M  135.1 DEG   2.21 M/SEC      6909.2 M  142.3 DEG    1.92 M/SEC
  5     145  CST   4262[illegible]4N.  744365E.   2198.4 M  130.7 DEG   2.44 M/SEC      9107.6 M  139.5 DEG    2.02 M/SEC
  6     130  CST   4261130N.  745979E.   2077.7 M  129.0 DEG   2.31 M/SEC     11185.3 M  137.6 DEG    2.07 M/SEC
  7     115  CST   4259953N.  747434E.   1979.4 M  132.7 DEG   2.20 M/SEC     13164.6 M  136.8 DEG    2.09 M/SEC
  8     100  CST   4258270N.  748[illegible]E.   2072.5 M  135.8 DEG   2.30 M/SEC     15237.2 M  136.7 DEG    2.12 M/SEC
  9      45  CST   4256867N.  750[illegible]E.   1968.6 M  139.8 DEG   2.19 M/SEC     17205.8 M  137.0 DEG    2.12 M/SEC
 10      30  CST   4255422N.  7511[illegible]E.   1784.5 M  144.6 DEG   1.98 M/SEC     18990.3 M  137.8 DEG    2.11 M/SEC
 11      15  CST   4254047N.  752[illegible]E.   1703.3 M  143.2 DEG   1.89 M/SEC     20693.6 M  138.2 DEG    2.09 M/SEC
 12       0  CST   4252880N.  753209E.   1535.9 M  139.1 DEG   1.71 M/SEC     22229.5 M  138.3 DEG    2.06 M/SEC
 13    2345  CST   4251617N.  754[illegible]E.   1489.5 M  130.6 DEG   1.66 M/SEC     23719.0 M  137.8 DEG    2.03 M/SEC
 14    2330  CST   4250[illegible]N.  755741E.   1681.5 M  123.5 DEG   1.87 M/SEC     25400.5 M  136.8 DEG    2.02 M/SEC
 15    2315  CST   4250[illegible]N.  757207E.   1747.0 M  123.0 DEG   1.94 M/SEC     27147.5 M  136.0 DEG    2.01 M/SEC
 16    2300  CST   4249[illegible]34N.  758[illegible]E.   1767.4 M  122.6 DEG   1.96 M/SEC     28914.9 M  135.1 DEG    2.01 M/SEC
 17    2245  CST   4248233N.  760213E.   1692.8 M  116.3 DEG   1.88 M/SEC     30607.7 M  134.1 DEG    2.[illegible] M/SEC
 18    2230  CST   4247573N.  761[illegible]E.   1629.3 M  113.7 DEG   1.81 M/SEC     32237.0 M  133.1 DEG    1.99 M/SEC
 19    2215  CST   4246933N.  763259E.   1709.9 M  115.1 DEG   1.90 M/SEC     33946.9 M  132.2 DEG    1.99 M/SEC
 20    2200  CST   4246333N.  764306E.   1679.7 M  112.4 DEG   1.87 M/SEC     35626.6 M  131.2 DEG    1.98 M/SEC
 21    2145  CST   4245724N.  766015E.   1904.9 M  108.0 DEG   2.12 M/SEC     37531.5 M  130.1 DEG    1.99 M/SEC
 22    2130  CST   4245208N.  767[illegible]E.   2222.5 M  103.4 DEG   2.47 M/SEC     39754.0 M  129.0 DEG    2.01 M/SEC
 23    2115  CST   4244779N.  771975E.   2234.0 M  101.1 DEG   2.49 M/SEC     41992.[illegible] M  127.[illegible] DEG    2.03 M/SEC
 24    2100  CST   4244350N.  773142E.   2205.8 M  100.9 DEG   2.45 M/SEC     44197.8 M  125.8 DEG    2.05 M/SEC
 25    2045  CST   4243[illegible]9N.  775155E.   2064.0 M  102.6 DEG   2.29 M/SEC     46262.3 M  124.8 DEG    2.06 M/SEC
 26    2030  CST   4243515N.  777092E.   1965.5 M  101.6 DEG   2.18 M/SEC     48227.9 M  123.8 DEG    2.06 M/SEC
 27    2015  CST   4243272N.  779108E.   2040.7 M   96.8 DEG   2.27 M/SEC     50268.5 M  122.7 DEG    2.07 M/SEC
 28    2000  CST   4243144N.  781030E.   1926.3 M   93.8 DEG   2.14 M/SEC     52194.9 M  121.7 DEG    2.07 M/SEC
 29    1945  CST   4243099N.  782664E.   1634.8 M   92.0 DEG   1.82 M/SEC     53829.6 M  120.8 DEG    2.06 M/SEC
 30    1930  CST   4243036N.  784124E.   1460.9 M   92.0 DEG   1.62 M/SEC     55290.5 M  120.0 DEG    2.05 M/SEC
 31    1915  CST   4243529N.  785233E.   1213.1 M   66.1 DEG   1.35 M/SEC     56503.5 M  119.0 DEG    2.03 M/SEC
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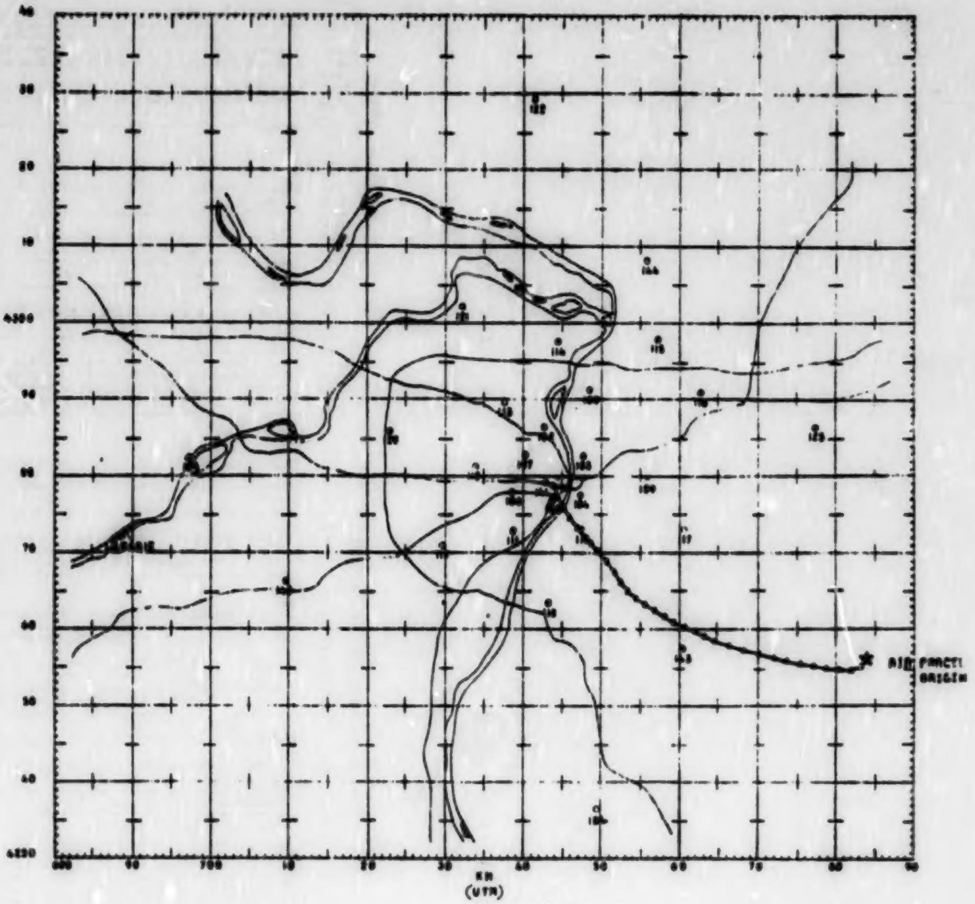
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KM
(UTM)
AIR PARCEL
ORIGIN

RAMS NEAR-SFC
TRAJECTORY #24
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1900 CDT 22 JUL 75
ARRIVING 300 CDT 22 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  1900 CST     END TIME: 23 JUL 75   300 CST
    INITIAL COORDINATES: 4279750N. 743880E.     LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 32

  .                                                                          ACCUMULATED DISPLACEMENT
                                             INCREMENTAL DISPLACEMENT      PATH      AZIMUTH         SPEED
STEP   TIME         LOCATION          RADIAL    AZIMUTH      SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0     300 CST  4279750N.  743880E.       0 M      0 DEG       0 M/SEC          0 M      0 DEG        0 M/SEC
  1     245 CST  4277345N.  744510E.  1543.0 M  155.6 DEG    1.71 M/SEC     1543.0 M  155.6 DEG     1.71 M/SEC
  2     230 CST  4275957N.  745240E.  1564.4 M  152.5 DEG    1.74 M/SEC     3107.4 M  154.0 DEG     1.73 M/SEC
  3     215 CST  4274600N.  746070E.  1594.7 M  148.3 DEG    1.77 M/SEC     4702.1 M  152.1 DEG     1.74 M/SEC
  4     200 CST  4273001N.  746979E.  1581.6 M  145.3 DEG    1.76 M/SEC     6283.7 M  150.4 DEG     1.75 M/SEC
  5     145 CST  4272182N.  747259E.  1422.4 M  141.9 DEG    1.58 M/SEC     7706.0 M  148.8 DEG     1.71 M/SEC
  6     130 CST  4271242N.  748780E.  1317.0 M  135.5 DEG    1.46 M/SEC     9023.0 M  146.9 DEG     1.67 M/SEC
  7     115 CST  4270172N.  749740E.  1443.2 M  137.9 DEG    1.60 M/SEC    10466.2 M  145.6 DEG     1.66 M/SEC
  8     100 CST  4268975N.  750810E.  1675.3 M  140.7 DEG    1.86 M/SEC    12141.5 M  144.9 DEG     1.69 M/SEC
  9      45 CST  4267534N.  751776E.  1636.3 M  143.8 DEG    1.82 M/SEC    13777.9 M  144.6 DEG     1.70 M/SEC
 10      30 CST  4266221N.  752580E.  1559.1 M  148.8 DEG    1.73 M/SEC    15337.0 M  145.2 DEG     1.70 M/SEC
 11      15 CST  4265042N.  753490E.  1488.2 M  142.4 DEG    1.65 M/SEC    16825.2 M  145.0 DEG     1.70 M/SEC
 12       0 CST  4264119N.  754563E.  1414.1 M  130.8 DEG    1.57 M/SEC    18239.3 M  143.9 DEG     1.69 M/SEC
 13    2345 CST  4263339N.  755677E.  1360.1 M  125.0 DEG    1.51 M/SEC    19599.4 M  142.6 DEG     1.68 M/SEC
 14    2330 CST  4262566N.  756940E.  1485.9 M  121.3 DEG    1.65 M/SEC    21085.3 M  141.1 DEG     1.67 M/SEC
 15    2315 CST  4261756N.  758190E.  1485.2 M  123.0 DEG    1.65 M/SEC    22570.5 M  139.9 DEG     1.67 M/SEC
 16    2300 CST  4261010N.  759342E.  1371.4 M  122.9 DEG    1.52 M/SEC    23941.9 M  138.9 DEG     1.66 M/SEC
 17    2245 CST  4260419N.  760712E.  1493.2 M  113.4 DEG    1.66 M/SEC    25435.1 M  137.4 DEG     1.66 M/SEC
 18    2230 CST  4259879N.  762033E.  1426.2 M  114.2 DEG    1.58 M/SEC    26861.3 M  136.1 DEG     1.66 M/SEC
 19    2215 CST  4259257N.  763220E.  1340.5 M  117.7 DEG    1.49 M/SEC    28201.8 M  135.2 DEG     1.65 M/SEC
 20    2200 CST  4258628N.  764553E.  1473.9 M  115.1 DEG    1.64 M/SEC    29675.7 M  134.2 DEG     1.65 M/SEC
 21    2145 CST  4258022N.  766321E.  1863.6 M  109.0 DEG    2.07 M/SEC    31539.3 M  132.7 DEG     1.67 M/SEC
 22    2130 CST  4257439N.  768249E.  2014.1 M  106.8 DEG    2.24 M/SEC    33553.4 M  131.2 DEG     1.69 M/SEC
 23    2115 CST  4256965N.  770243E.  2054.3 M  103.4 DEG    2.28 M/SEC    35607.7 M  129.6 DEG     1.72 M/SEC
 24    2100 CST  4256409N.  772054E.  1873.5 M  104.8 DEG    2.08 M/SEC    37481.2 M  128.3 DEG     1.74 M/SEC
 25    2045 CST  4256041N.  773752E.  1755.0 M  104.6 DEG    1.95 M/SEC    39236.2 M  127.2 DEG     1.74 M/SEC
 26    2030 CST  4255673N.  775421E.  1709.5 M  102.4 DEG    1.90 M/SEC    40945.7 M  126.2 DEG     1.75 M/SEC
 27    2015 CST  4255403N.  777181E.  1781.2 M   98.8 DEG    1.98 M/SEC    42726.9 M  125.0 DEG     1.76 M/SEC
 28    2000 CST  4255140N.  778749E.  1589.1 M   99.4 DEG    1.77 M/SEC    44316.0 M  124.1 DEG     1.76 M/SEC
 29    1945 CST  4254991N.  780365E.  1623.4 M   95.3 DEG    1.80 M/SEC    45939.4 M  123.1 DEG     1.76 M/SEC
 30    1930 CST  4254871N.  781942E.  1581.1 M   94.4 DEG    1.76 M/SEC    47520.5 M  122.1 DEG     1.76 M/SEC
 31    1915 CST  4255354N.  783151E.  1301.7 M   68.2 DEG    1.45 M/SEC    48822.2 M  120.8 DEG     1.75 M/SEC
 32    1900 CST  4256392N.  783886E.  1272.4 M   35.3 DEG    1.41 M/SEC    50094.6 M  119.2 DEG     1.74 M/SEC
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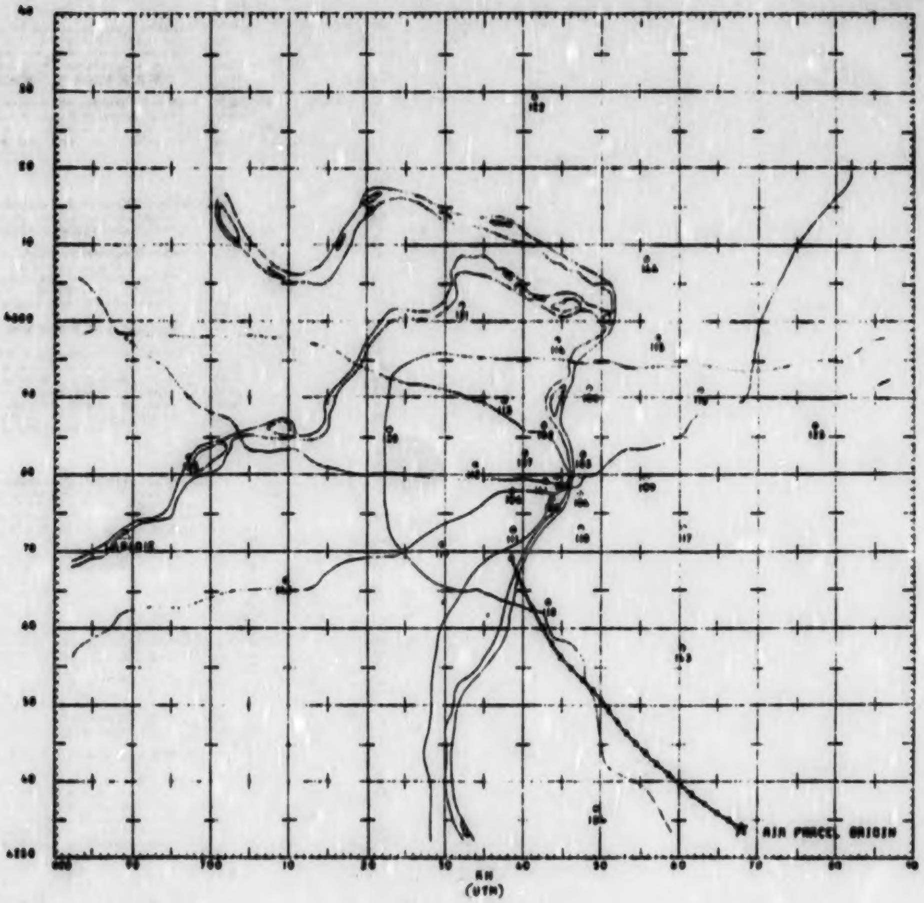
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #25
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 115 CST 23 JUL 75
ARRIVING 700 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 23 JUL 75   115 CST     END TIME: 23 JUL 75   700 CST
     INITIAL COORDINATES: 4269380N. 738500E.     LOCATION DESCRIPTOR: BROADWAY AND HURCK
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 23

                                                                                  ACCUMULATED DISPLACEMENT
                                             INCREMENTAL DISPLACEMENT         PATH       AZIMUTH           SPEED
STEP   TIME         LOCATION           RADIAL     AZIMUTH       SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    700 CST   4269380N. 738500E.        0 M       0 DEG      0 M/SEC         0 M       0 DEG        0 M/SEC
  1    645 CST   4267376N. 739230E.   2132.9 M   160.0 DEG   2.37 M/SEC    2132.9 M   160.0 DEG     2.37 M/SEC
  2    630 CST   4265204N. 740046E.   2320.4 M   159.4 DEG   2.58 M/SEC    4453.3 M   159.7 DEG     2.47 M/SEC
  3    615 CST   4262750N. 741189E.   2709.8 M   155.0 DEG   3.01 M/SEC    7163.1 M   157.9 DEG     2.65 M/SEC
  4    600 CST   4260295N. 742503E.   2785.7 M   151.9 DEG   3.10 M/SEC    9948.8 M   156.2 DEG     2.76 M/SEC
  5    545 CST   4258167N. 743647E.   2411.5 M   151.7 DEG   2.68 M/SEC   12360.3 M   155.3 DEG     2.75 M/SEC
  6    530 CST   4256474N. 744813E.   2055.9 M   145.4 DEG   2.28 M/SEC   14416.2 M   153.9 DEG     2.67 M/SEC
  7    515 CST   4254981N. 746178E.   2023.1 M   137.6 DEG   2.25 M/SEC   16439.3 M   151.9 DEG     2.61 M/SEC
  8    500 CST   4253540N. 747617E.   2035.2 M   135.1 DEG   2.26 M/SEC   18475.6 M   150.1 DEG     2.57 M/SEC
  9    445 CST   4252177N. 748933E.   1893.8 M   136.0 DEG   2.10 M/SEC   20368.8 M   148.8 DEG     2.51 M/SEC
 10    430 CST   4250861N. 749973E.   1678.7 M   141.7 DEG   1.87 M/SEC   22047.5 M   148.2 DEG     2.45 M/SEC
 11    415 CST   4249497N. 750911E.   1655.4 M   145.5 DEG   1.84 M/SEC   23702.9 M   148.0 DEG     2.39 M/SEC
 12    400 CST   4248068N. 752012E.   1803.8 M   142.4 DEG   2.00 M/SEC   25506.7 M   147.0 DEG     2.36 M/SEC
 13    345 CST   4246644N. 753181E.   1842.9 M   140.9 DEG   2.05 M/SEC   27349.3 M   147.1 DEG     2.34 M/SEC
 14    330 CST   4245334N. 754332E.   1744.5 M   138.7 DEG   1.94 M/SEC   29093.8 M   146.0 DEG     2.31 M/SEC
 15    315 CST   4244029N. 755573E.   1800.5 M   136.5 DEG   2.00 M/SEC   30894.3 M   145.6 DEG     2.29 M/SEC
 16    300 CST   4242654N. 756999E.   1980.7 M   134.0 DEG   2.20 M/SEC   32875.2 M   145.3 DEG     2.28 M/SEC
 17    245 CST   4241273N. 758547E.   2070.3 M   131.6 DEG   2.30 M/SEC   34945.5 M   144.3 DEG     2.28 M/SEC
 18    230 CST   4239962N. 759991E.   1955.9 M   132.4 DEG   2.17 M/SEC   36901.4 M   143.9 DEG     2.28 M/SEC
 19    215 CST   4238700N. 761465E.   1939.0 M   130.5 DEG   2.15 M/SEC   38840.4 M   143.2 DEG     2.27 M/SEC
 20    200 CST   4237418N. 763079E.   2061.8 M   129.4 DEG   2.29 M/SEC   40902.2 M   142.4 DEG     2.27 M/SEC
 21    145 CST   4236294N. 764701E.   1972.6 M   124.7 DEG   2.19 M/SEC   42874.3 M   141.6 DEG     2.27 M/SEC
 22    130 CST   4235362N. 766195E.   1761.1 M   122.0 DEG   1.96 M/SEC   44635.9 M   140.8 DEG     2.25 M/SEC
 23    115 CST   4234263N. 767714E.   1875.9 M   126.0 DEG   2.08 M/SEC   46512.8 M   140.2 DEG     2.25 M/SEC
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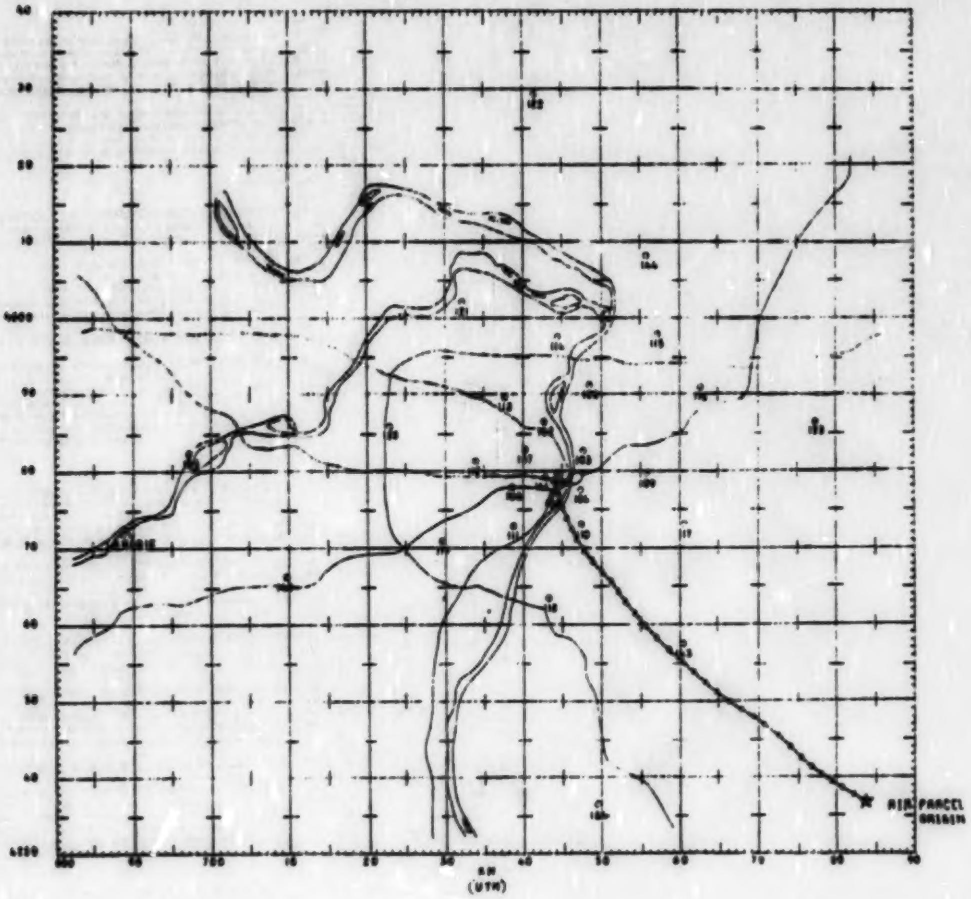
AIR PARCEL ORIGIN
700
4000
(UTM)

RAMS NEAR-SFC
TRAJECTORY #26
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 2300 CST 22 JUL 75
ARRIVING 700 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 22 JUL 75  2300 CST      END TIME: 23 JUL 75   700 CST
    INITIAL COORDINATES: 4278750N. 743880E.      LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 32

                                                                                    ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT
                                                                                PATH       AZIMUTH          SPEED
STEP   TIME           LOCATION           RADIAL    AZIMUTH      SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0     700 CST  4278750N.  743880E.       0 M      0 DEG      0 M/SEC         0 M       0 DEG          0 M/SEC
  1     645 CST  4277143N.  744473E.  1712.9 M  159.7 DEG   1.90 M/SEC    1712.9 M   159.7 DEG       1.90 M/SEC
  2     630 CST  4275531N.  744955E.  1694.6 M  162.0 DEG   1.88 M/SEC    3407.6 M   160.8 DEG       1.89 M/SEC
  3     615 CST  4273963N.  745592E.  1673.7 M  159.3 DEG   1.86 M/SEC    5084.2 M   160.3 DEG       1.88 M/SEC
  4     600 CST  4272550N.  746227E.  1549.2 M  155.9 DEG   1.72 M/SEC    6633.4 M   159.3 DEG       1.84 M/SEC
  5     545 CST  4271190N.  746897E.  1515.6 M  153.9 DEG   1.69 M/SEC    8149.7 M   158.2 DEG       1.81 M/SEC
  6     530 CST  4269725N.  747805E.  1704.3 M  147.3 DEG   1.89 M/SEC    9854.2 M   156.4 DEG       1.82 M/SEC
  7     515 CST  4268328N.  748934E.  1813.4 M  141.5 DEG   2.01 M/SEC   11667.6 M   154.1 DEG       1.83 M/SEC
  8     500 CST  4266958N.  750152E.  1833.0 M  138.4 DEG   2.04 M/SEC   13500.6 M   152.0 DEG       1.88 M/SEC
  9     445 CST  4265690N.  751295E.  1701.2 M  138.2 DEG   1.89 M/SEC   15201.8 M   151.4 DEG       1.88 M/SEC
 10     430 CST  4264446N.  752226E.  1547.6 M  143.5 DEG   1.72 M/SEC   16749.3 M   149.8 DEG       1.86 M/SEC
 11     415 CST  4263114N.  753307E.  1587.9 M  147.0 DEG   1.76 M/SEC   18337.2 M   149.6 DEG       1.85 M/SEC
 12     400 CST  4261553N.  754259E.  1949.9 M  142.5 DEG   2.17 M/SEC   20287.0 M   148.9 DEG       1.88 M/SEC
 13     345 CST  4259901N.  755648E.  2170.3 M  143.2 DEG   2.41 M/SEC   22457.4 M   148.0 DEG       1.92 M/SEC
 14     330 CST  4258273N.  757054E.  2076.9 M  137.4 DEG   2.31 M/SEC   24533.9 M   147.1 DEG       1.95 M/SEC
 15     315 CST  4256833N.  758631E.  2189.8 M  134.0 DEG   2.43 M/SEC   26723.7 M   146.0 DEG       1.98 M/SEC
 16     300 CST  4255373N.  760236E.  2185.4 M  132.8 DEG   2.43 M/SEC   28909.1 M   145.0 DEG       2.01 M/SEC
 17     245 CST  4253993N.  761772E.  2061.5 M  131.8 DEG   2.29 M/SEC   30970.6 M   144.1 DEG       2.02 M/SEC
 18     230 CST  4252671N.  763219E.  1961.1 M  132.5 DEG   2.16 M/SEC   32931.7 M   143.4 DEG       2.03 M/SEC
 19     215 CST  4251426N.  764627E.  1925.4 M  135.3 DEG   2.14 M/SEC   34857.1 M   142.7 DEG       2.04 M/SEC
 20     200 CST  4250177N.  765291E.  2024.0 M  129.1 DEG   2.25 M/SEC   36881.3 M   141.9 DEG       2.05 M/SEC
 21     145 CST  4247333N.  767873E.  1923.1 M  124.1 DEG   2.14 M/SEC   38804.7 M   141.0 DEG       2.05 M/SEC
 22     130 CST  4248237N.  769329E.  1706.5 M  121.4 DEG   1.90 M/SEC   40511.2 M   140.2 DEG       2.05 M/SEC
 23     115 CST  4247141N.  770821E.  1835.4 M  125.6 DEG   2.04 M/SEC   42346.5 M   139.6 DEG       2.05 M/SEC
 24     100 CST  4245797N.  772564E.  2172.1 M  129.2 DEG   2.41 M/SEC   44518.3 M   139.0 DEG       2.06 M/SEC
 25      45 CST  4244239N.  774052E.  2140.1 M  133.7 DEG   2.38 M/SEC   46658.9 M   138.8 DEG       2.07 M/SEC
 26      30 CST  4242372N.  775443E.  1987.2 M  135.5 DEG   2.21 M/SEC   48646.0 M   138.7 DEG       2.08 M/SEC
 27      15 CST  4241673N.  775758E.  1785.2 M  132.2 DEG   1.98 M/SEC   50431.2 M   138.4 DEG       2.08 M/SEC
 28       0 CST  4243683N.  779031E.  1604.9 M  128.1 DEG   1.78 M/SEC   52036.1 M   138.1 DEG       2.06 M/SEC
 29    2345 CST  4239730N.  779323E.  1569.3 M  124.7 DEG   1.74 M/SEC   53604.0 M   137.7 DEG       2.05 M/SEC
 30    2330 CST  4238945N.  780639E.  1615.9 M  121.5 DEG   1.90 M/SEC   55220.4 M   137.2 DEG       2.05 M/SEC
 31    2315 CST  4238075N.  782121E.  1668.5 M  121.4 DEG   1.85 M/SEC   56888.3 M   136.8 DEG       2.04 M/SEC
 32    2300 CST  4237173N.  783593E.  1725.0 M  121.5 DEG   1.92 M/SEC   58614.9 M   136.3 DEG       2.04 M/SEC
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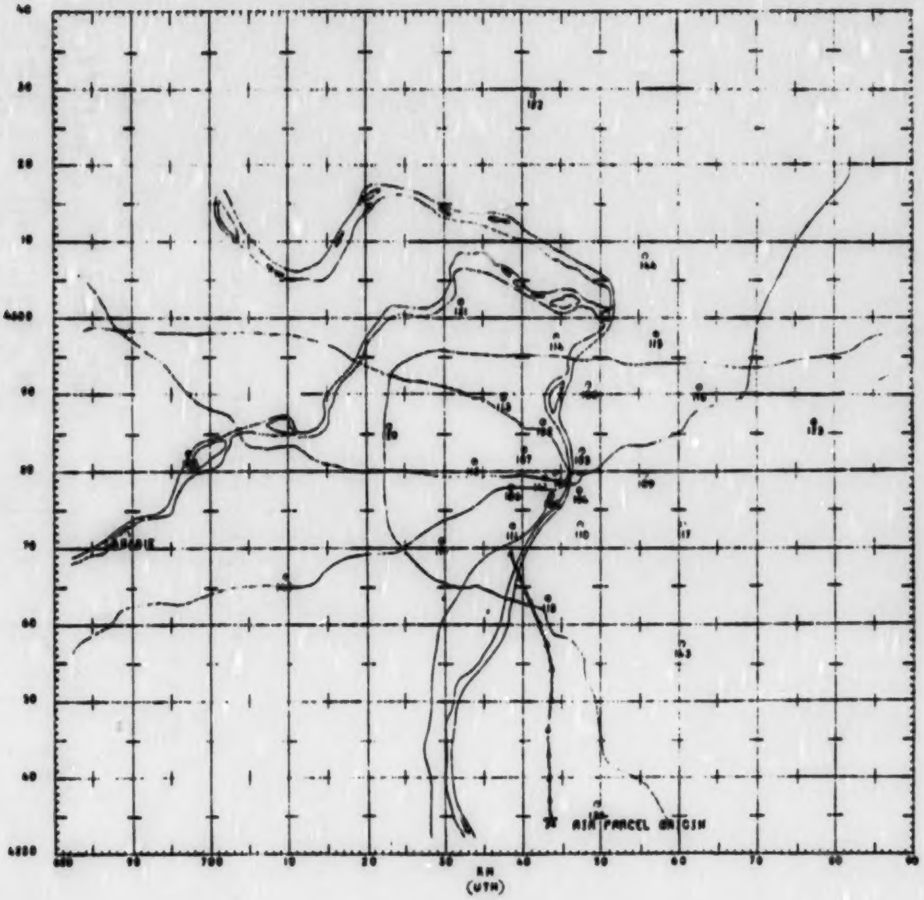
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(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY **#27**
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 815 CST 23 JUL 75
ARRIVING 1100 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 23 JUL 75   815 CST     END TIME: 23 JUL 75  1100 CST

    INITIAL COORDINATES: 4269380N. 7385000E.     LOCATION DESCRIPTOR: BROADWAY AND HURCK

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN             NUMBER OF STEPS: 11

                                                                                   ACCUMULATED DISPLACEMENT
                                               INCREMENTAL DISPLACEMENT             PATH       AZIMUTH        SPEED
                                           RADIAL     AZIMUTH      SPEED           LENGTH  (FROM ORIGIN) (ALONG PATH)
STEP   TIME        LOCATION

  0   1100 CST  4269380N. 7385000E.          0 M       0 DEG        0 M/SEC           0 M      0 DEG        0 M/SEC
  1   1045 CST  4266352N. 7396498E.     3232.7 M   159.2 DEG     3.59 M/SEC      3232.7 M  159.2 DEG     3.59 M/SEC
  2   1030 CST  4263133N. 7409418E.     3474.7 M   158.2 DEG     3.86 M/SEC      6707.4 M  158.7 DEG     3.73 M/SEC
  3   1015 CST  4260245N. 7421420E.     3127.1 M   157.4 DEG     3.47 M/SEC      9834.5 M  158.3 DEG     3.64 M/SEC
  4   1000 CST  4257588N. 7431[illegible]E.     2825.[illegible] M   160.2 DEG     3.14 M/SEC     12659.7 M  158.7 DEG     3.52 M/SEC
  5    945 CST  4254473N. 7437330E.     3179.0 M   168.5 DEG     3.53 M/SEC     15838.7 M  160.8 DEG     3.52 M/SEC
  6    930 CST  4250464N. 7436020E.     40[illegible].8 M   191.9 DEG     4.46 M/SEC     19849.5 M  164.9 DEG     3.68 M/SEC
  7    915 CST  4246579N. 7431[illegible]E.     3906.4 M   196.1 DEG     4.34 M/SEC     23755.9 M  168.4 DEG     3.77 M/SEC
  8    900 CST  4243340N. 7432210E.     3239.6 M   179.4 DEG     3.60 M/SEC     26995.5 M  169.7 DEG     3.75 M/SEC
  9    845 CST  4240266N. 7433080E.     3075.1 M   178.4 DEG     3.42 M/SEC     3007[illegible].6 M  173.6 DEG     3.7[illegible] M/SEC
 10    830 CST  4237457N. 7433760E.     28[illegible].3 M   178.6 DEG     3.12 M/SEC     328[illegible].3 M  171.3 DEG     3.65 M/SEC
 11    815 CST  4234751N. 7434440E.     2736.4 M   178.5 DEG     3.01 M/SEC     35587.1 M  171.9 DEG     3.59 M/SEC
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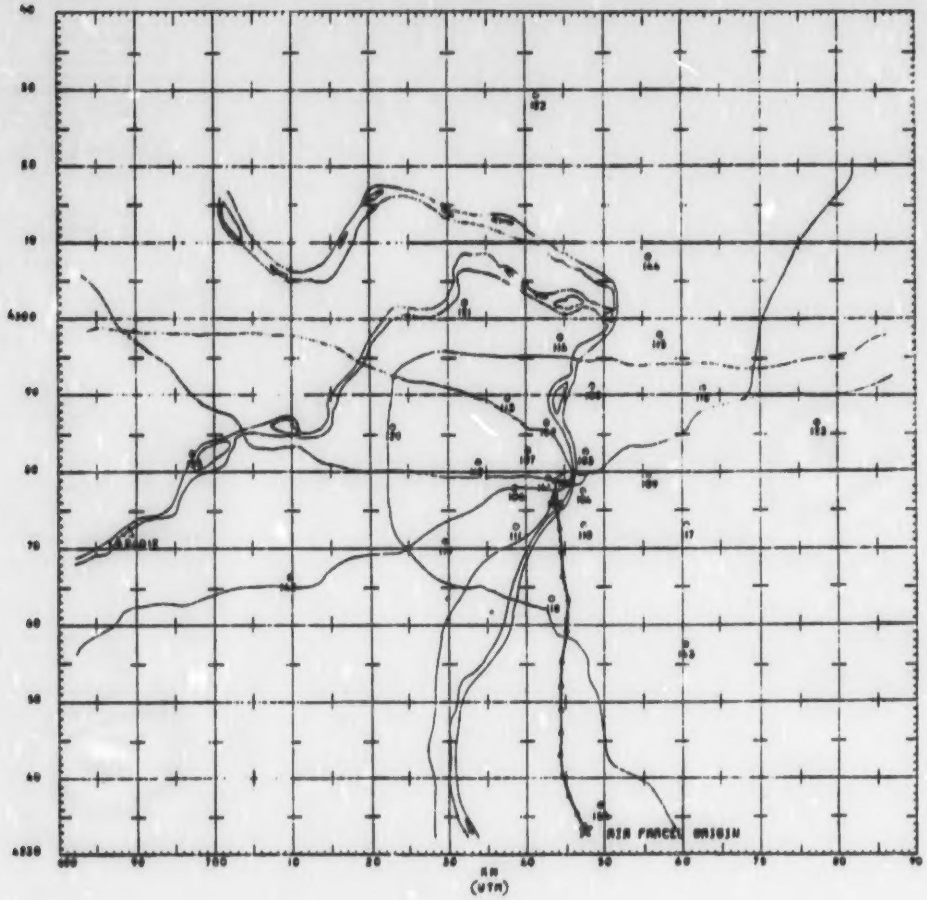
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(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #28
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 715 CST 23 JUL 75
ARRIVING 1100 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 23 JUL 75   715 CST      END TIME: 23 JUL 75  1100 CST

    INITIAL COORDINATES: 4278750N. 743880E.      LOCATION DESCRIPTOR: 14TH AND MARKET

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 15

                                                                                      ACCUMULATED DISPLACEMENT
                                                    INCREMENTAL DISPLACEMENT       PATH       AZIMUTH          SPEED
STEP   TIME          LOCATION              RADIAL    AZIMUTH  .  SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0   1100 CST   4278750N.  743880E.          0 M       0 DEG       0 M/SEC          0 M       0 DEG          0 M/SEC
  1   1045 CST   4275696N.  744074E.     3059.7 M   176.4 DEG    3.40 M/SEC     3059.7 M   176.4 DEG       3.40 M/SEC
  2   1030 CST   4272631N.  744433E.     3065.7 M   173.3 DEG    3.43 M/SEC     6145.5 M   174.8 DEG       3.41 M/SEC
  3   1015 CST   4269600N.  744544E.     3033.0 M   176.0 DEG    3.37 M/SEC     9176.5 M   175.2 DEG       3.40 M/SEC
  4   1000 CST   4266429N.  744778E.     3179.7 M   177.6 DEG    3.53 M/SEC    12356.2 M   175.6 DEG       3.43 M/SEC
  5    945 CST   4263323N.  745305E.     3184.4 M   166.8 DEG    3.54 M/SEC    15542.0 M   174.0 DEG       3.45 M/SEC
  6    930 CST   4259315N.  745279E.     4013.6 M   183.2 DEG    4.47 M/SEC    19561.2 M   175.9 DEG       3.62 M/SEC
  7    915 CST   4255353N.  744508E.     [illegible] M   189.6 DEG    4.46 M/SEC    23571.2 M   178.2 DEG       3.74 M/SEC
  8    900 CST   4252215N.  744516E.     3147.0 M   181.7 DEG    3.50 M/SEC    26719.1 M   178.6 DEG       3.71 M/SEC
  9    845 CST   4249138N.  744491E.     3078.2 M   180.5 DEG    3.42 M/SEC    29797.3 M   178.8 DEG       3.68 M/SEC
 10    830 CST   4246210N.  744445E.     2927.0 M   180.9 DEG    3.25 M/SEC    32720.3 M   179.0 DEG       3.64 M/SEC
 11    815 CST   4243337N.  744390E.     2872.9 M   181.1 DEG    3.19 M/SEC    35598.9 M   179.2 DEG       3.60 M/SEC
 12    800 CST   4240540N.  744335E.     2807.9 M   179.0 DEG    3.12 M/SEC    38405.8 M   178.9 DEG       3.56 M/SEC
 13    745 CST   4237976N.  745427E.     2683.9 M   162.9 DEG    2.98 M/SEC    41090.6 M   177.8 DEG       3.54 M/SEC
 14    730 CST   4235628N.  746471E.     2569.9 M   156.0 DEG    2.86 M/SEC    43660.5 M   176.6 DEG       3.47 M/SEC
 15    715 CST   4233554N.  747457E.     2295.7 M   154.6 DEG    2.55 M/SEC    45956.1 M   175.9 DEG       3.40 M/SEC
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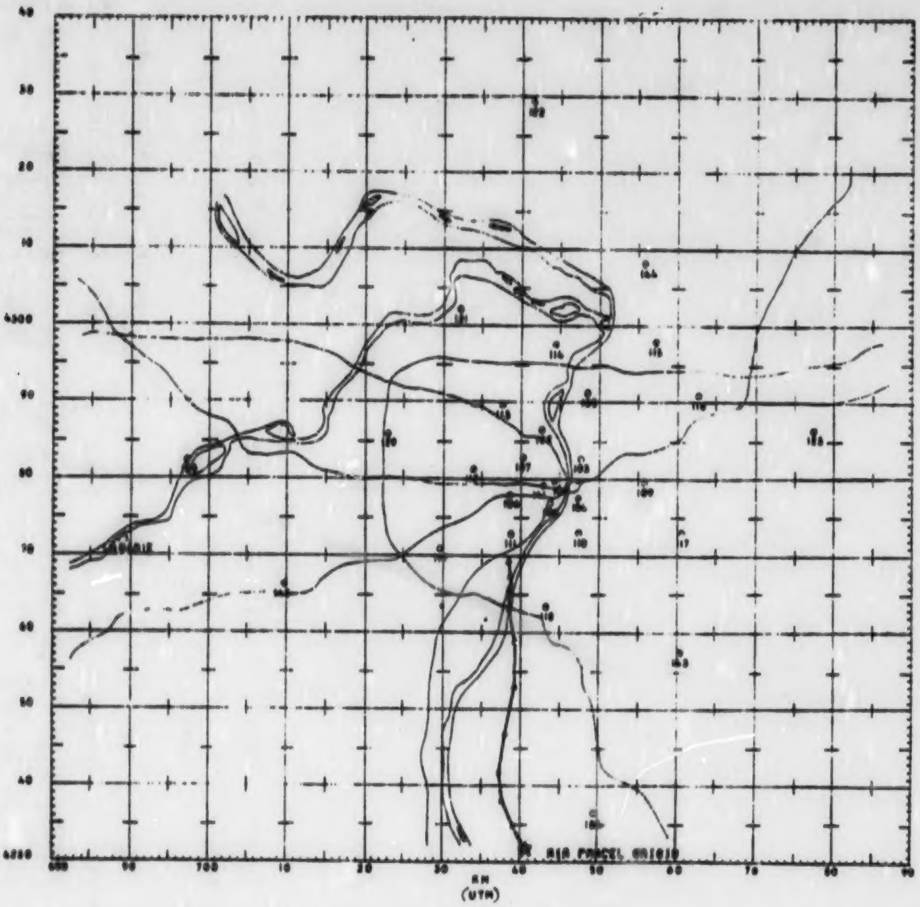
EQR, INC 225 S.MERAMEC ST.LOUIS MO. 63105 (1-314-725-2122)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(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #29
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1200 CST 23 JUL 75
ARRIVING 1500 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

ENVIRONMENTAL QUALITY RESEARCH
225 S. MERAMEC
CLAYTON,MISSOURI  63105
     PHONE:1-314-725-2122


     START TIME: 23 JUL 75  1200 CST      END TIME: 23 JUL 75  1500 CST

     INITIAL COORDINATES: 4269380N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK

     TRAJECTORY TYPE: BACKWARD IN TIME

     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 12

                                                                                  ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT
                                                                          PATH       AZIMUTH          SPEED
STEP    TIME         LOCATION            RADIAL    AZIMUTH       SPEED          LENGTH   (FROM ORIGIN) (ALONG PATH)

  0     1500 CST   4269380N.  738500E.        0 M       0 DEG      0 M/SEC          0 M      0 DEG        0 M/SEC
  1     1445 CST   4267321N.  738657E.   2064.1 M  175.6 DEG   2.29 M/SEC     2064.1 M  175.6 DEG     2.29 M/SEC
  2     1430 CST   4266164N.  738777E.   1163.8 M  174.1 DEG   1.29 M/SEC     3227.9 M  175.1 DEG     1.79 M/SEC
  3     1415 CST   4265816N.  738609E.    386.6 M  205.9 DEG   0.43 M/SEC     3614.5 M  178.2 DEG     1.34 M/SEC
  4     1400 CST   4265137N.  738442E.    699.1 M  193.8 DEG   0.78 M/SEC     4313.5 M  180.8 DEG     1.20 M/SEC
  5     1345 CST   4263201N.  738495E.   1936.1 M  178.4 DEG   2.15 M/SEC     6249.6 M  180.0 DEG     1.39 M/SEC
  6     1330 CST   4259922N.  739223E.   4343.9 M  170.4 DEG   4.82 M/SEC    10593.5 M  176.0 DEG     1.96 M/SEC
  7     1315 CST   4253077N.  739186E.   5842.1 M  190.4 DEG   6.49 M/SEC    16435.6 M  177.6 DEG     2.61 M/SEC
  8     1300 CST   4246974N.  737989E.   6219.2 M  191.1 DEG   6.91 M/SEC    22654.8 M  181.3 DEG     3.15 M/SEC
  9     1245 CST   4241383N.  737231E.   5048.4 M  188.6 DEG   5.61 M/SEC    27703.2 M  182.7 DEG     3.42 M/SEC
 10     1230 CST   4238313N.  737601E.   3683.8 M  174.3 DEG   4.10 M/SEC    31387.0 M  181.7 DEG     3.49 M/SEC
 11     1215 CST   4235043N.  738979E.   3548.6 M  157.1 DEG   3.94 M/SEC    34935.0 M  179.2 DEG     3.53 M/SEC
 12     1200 CST   4232766N.  740553E.   3357.7 M  152.1 DEG   3.74 M/SEC    38307.6 M  176.9 DEG     3.55 M/SEC
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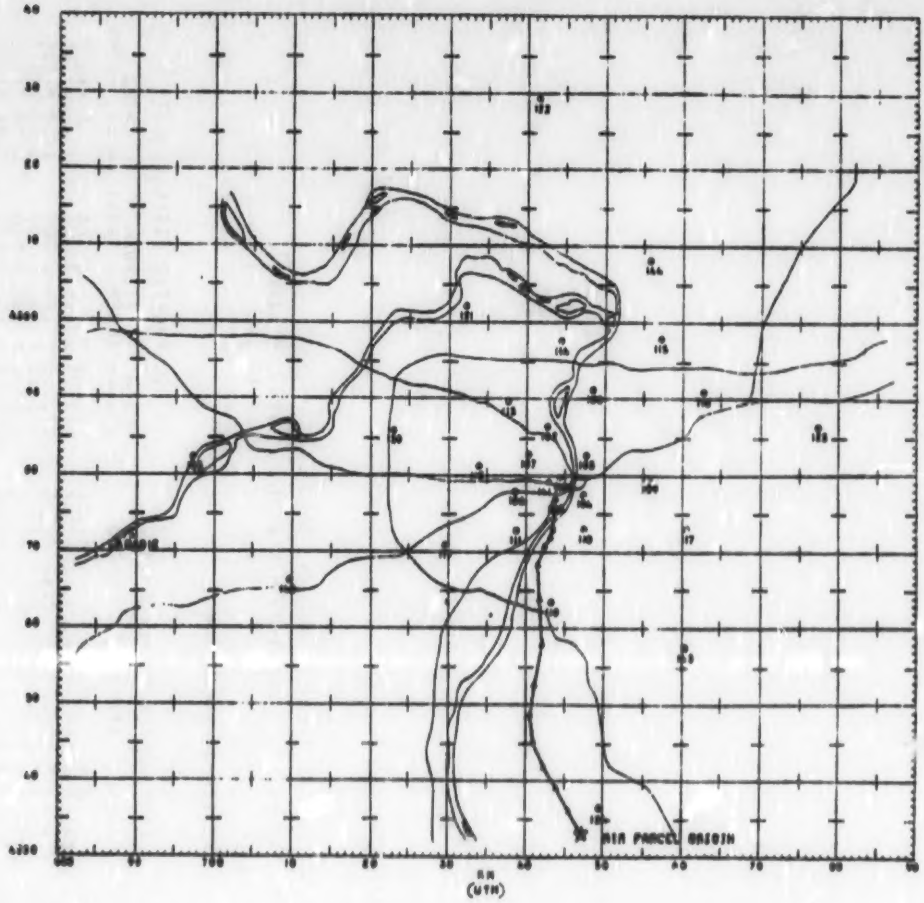
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(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #30
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1130 CST 23 JUL 75
ARRIVING 1500 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 23 JUL 75  1130 CST     END TIME: 23 JUL 75  1500 CST
     INITIAL COORDINATES: 4278750N. 743880E.     LOCATION DESCRIPTOR: 14TH AND MARKET
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 14

                                                                                 ACCUMULATED DISPLACEMENT
                                           INCREMENTAL DISPLACEMENT          PATH      AZIMUTH          SPEED
STEP   TIME        LOCATION            RADIAL    AZIMUTH      SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    1500 CST  4278750N.  743880E.       0 M       0 DEG       0 M/SEC        0 M       0 DEG        0 M/SEC
  1    1445 CST  4275580N.  743590E.  3183.0 M   185.2 DEG    3.54 M/SEC   3183.0 M   185.2 DEG     3.54 M/SEC
  2    1430 CST  4273065N.  743480E.  2517.5 M   182.5 DEG    2.80 M/SEC   5700.5 M   184.0 DEG     3.17 M/SEC
  3    1415 CST  4272011N.  743119E.  1114.3 M   198.9 DEG    1.24 M/SEC   6814.3 M   185.4 DEG     2.52 M/SEC
  4    1400 CST  4270336N.  742438E.  1357.3 M   210.1 DEG    1.51 M/SEC   8172.1 M   190.3 DEG     2.27 M/SEC
  5    1345 CST  4268467N.  741563E.  2525.5 M   200.3 DEG    2.81 M/SEC  10697.5 M   192.7 DEG     2.38 M/SEC
  6    1330 CST  4263983N.  741821E.  4491.2 M   176.7 DEG    4.99 M/SEC  15188.7 M   187.9 DEG     2.81 M/SEC
  7    1315 CST  4258100N.  742130E.  5891.4 M   177.0 DEG    6.55 M/SEC  21080.1 M   184.8 DEG     3.35 M/SEC
  8    1300 CST  4252814N.  741137E.  5373.7 M   190.6 DEG    5.98 M/SEC  26458.8 M   186.0 DEG     3.67 M/SEC
  9    1245 CST  4248984N.  740525E.  3977.6 M   188.3 DEG    4.42 M/SEC  30430.4 M   186.4 DEG     3.76 M/SEC
 10    1230 CST  4245420N.  740956E.  3489.7 M   172.9 DEG    3.88 M/SEC  33920.1 M   185.0 DEG     3.77 M/SEC
 11    1215 CST  4242134N.  742343E.  3556.8 M   157.1 DEG    3.96 M/SEC  37493.2 M   182.4 DEG     3.79 M/SEC
 12    1200 CST  4239402N.  743924E.  3155.9 M   149.9 DEG    3.51 M/SEC  40650.1 M   179.9 DEG     3.76 M/SEC
 13    1145 CST  4236473N.  745490E.  3321.1 M   151.9 DEG    3.69 M/SEC  43971.2 M   177.8 DEG     3.76 M/SEC
 14    1130 CST  4233537N.  747095E.  3346.5 M   151.3 DEG    3.72 M/SEC  47317.7 M   175.9 DEG     3.76 M/SEC
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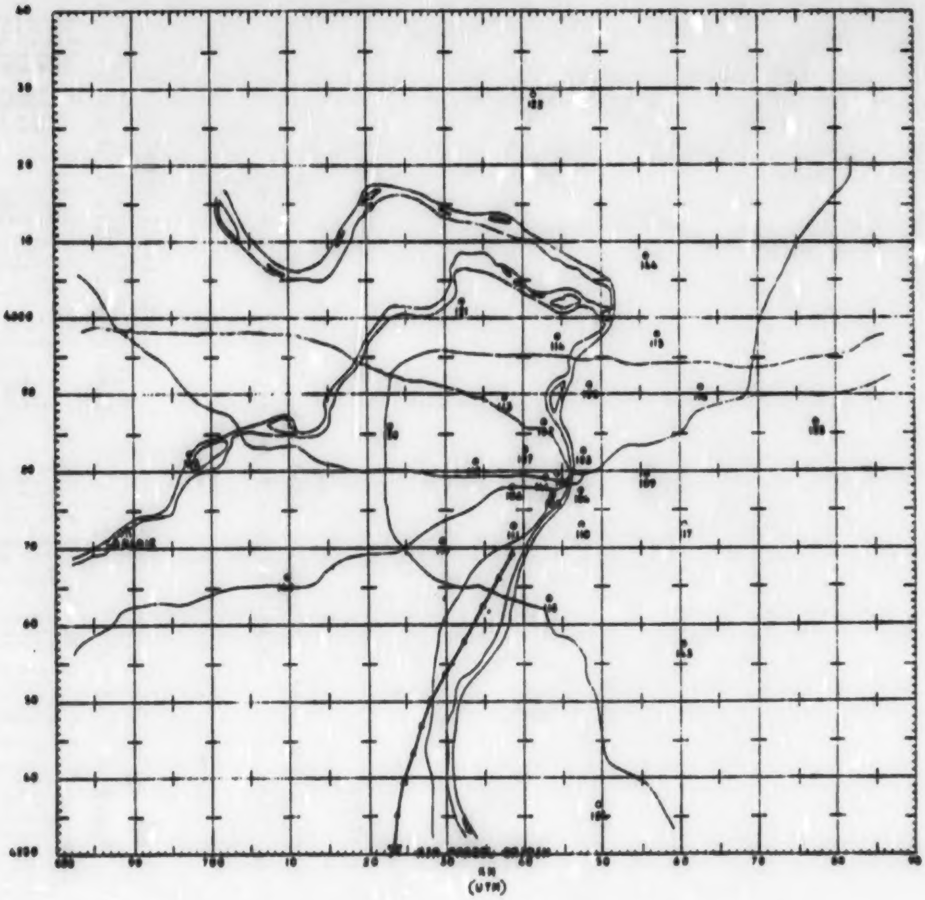
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AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #31
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1630 CST 23 JUL 75
ARRIVING 1900 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

   START TIME: 23 JUL 75  1630 CST      END TIME: 23 JUL 75  1900 CST

   INITIAL COORDINATES: 4269380N. 738500E.     LOCATION DESCRIPTOR: BROADWAY AND HURCK

   TRAJECTORY TYPE: BACKWARD IN TIME

   STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 10

                                                                                   ACCUMULATED DISPLACEMENT
                                        INCREMENTAL DISPLACEMENT
                                                                          PATH       AZIMUTH         SPEED
STEP   TIME         LOCATION          RADIAL    AZIMUTH      SPEED       LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    1900 CST  4269380N. 738500E.       0 M      0 DEG     0 M/SEC        0 M      0 DEG       0 M/SEC
  1    1845 CST  4266225N. 736749E.  3608.0 M  209.0 DEG  4.01 M/SEC   3608.0 M  209.0 DEG    4.01 M/SEC
  2    1830 CST  4262640N. 734763E.  4091.7 M  209.0 DEG  4.55 M/SEC   7699.7 M  209.0 DEG    4.28 M/SEC
  3    1815 CST  4258022N. 732322E.  5229.8 M  207.9 DEG  5.81 M/SEC  12929.5 M  208.5 DEG    4.79 M/SEC
  4    1800 CST  4253822N. 729833E.  4882.3 M  210.6 DEG  5.42 M/SEC  17811.8 M  209.1 DEG    4.95 M/SEC
  5    1745 CST  4250419N. 727970E.  3878.9 M  208.7 DEG  4.31 M/SEC  21690.7 M  209.0 DEG    4.82 M/SEC
  6    1730 CST  4247137N. 726809E.  3481.6 M  199.5 DEG  3.87 M/SEC  25172.3 M  207.7 DEG    4.66 M/SEC
  7    1715 CST  4243575N. 725740E.  3719.0 M  196.7 DEG  4.13 M/SEC  28891.3 M  206.3 DEG    4.59 M/SEC
  8    1700 CST  4239761N. 724416E.  4036.6 M  199.1 DEG  4.49 M/SEC  32928.4 M  205.4 DEG    4.57 M/SEC
  9    1645 CST  4235570N. 723651E.  4260.3 M  190.3 DEG  4.73 M/SEC  37188.7 M  203.7 DEG    4.59 M/SEC
 10    1630 CST  4231318N. 722503E.  4405.4 M  195.1 DEG  4.99 M/SEC  41594.1 M  201.8 DEG    4.62 M/SEC
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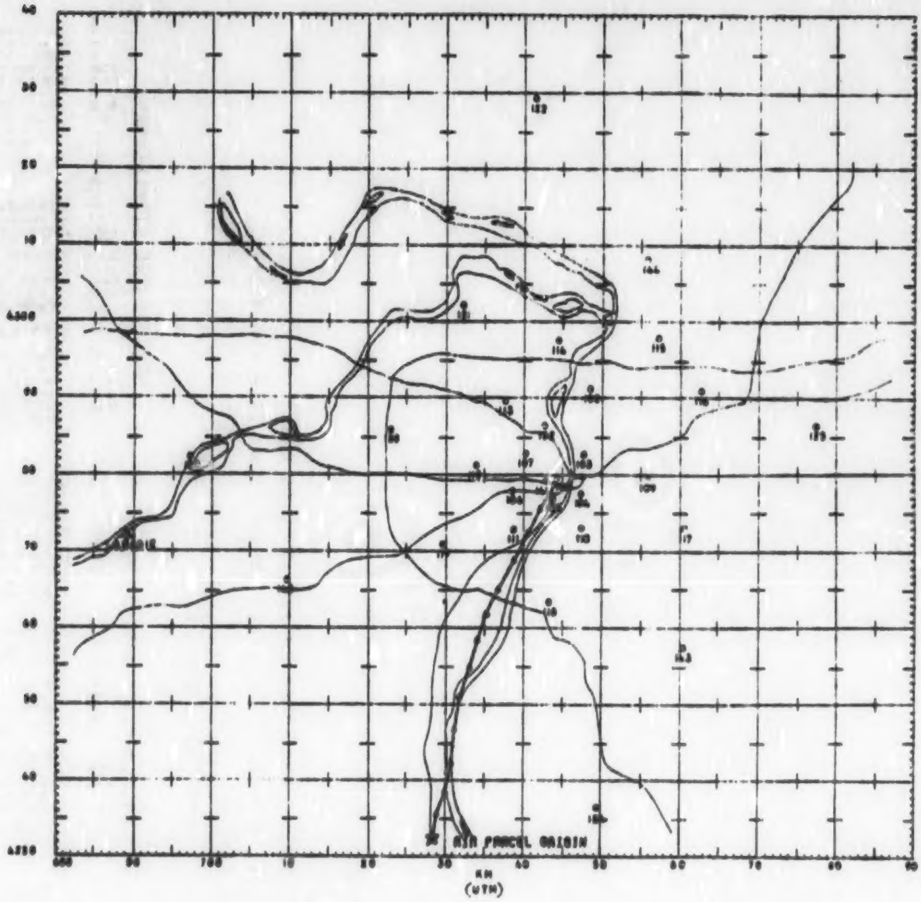
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KM
(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC TRAJECTORY #32

ST. LOUIS, MO.

LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1545 CST 23 JUL 75
ARRIVING 1900 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

   START TIME: 23 JUL 75  1545 CST      END TIME: 23 JUL 75  1900 CST

   INITIAL COORDINATES: 4278750N. 743890E.     LOCATION DESCRIPTOR: 14TH AND MARKET

   TRAJECTORY TYPE: BACKWARD IN TIME

   STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 13

                                                                                 ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT              PATH      AZIMUTH          SPEED
STEP   TIME          LOCATION           RADIAL     AZIMUTH      SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    1900 CST   4278750N.  743890E.        0 M       0 DEG      0 M/SEC         0 M       0 DEG       0 M/SEC
  1    1845 CST   4275609N.  742080E.   3619.0 M   209.8 DEG   4.02 M/SEC    3619.0 M   209.8 DEG    4.02 M/SEC
  2    1830 CST   4272567N.  740529E.   3414.8 M   207.0 DEG   3.79 M/SEC    7033.8 M   208.5 DEG    3.91 M/SEC
  3    1815 CST   4268904N.  738664E.   4111.2 M   207.0 DEG   4.57 M/SEC   11145.0 M   207.9 DEG    4.13 M/SEC
  4    1800 CST   4265193N.  736662E.   4214.7 M   208.3 DEG   4.68 M/SEC   15359.7 M   208.0 DEG    4.27 M/SEC
  5    1745 CST   4261898N.  735047E.   3670.7 M   206.1 DEG   4.08 M/SEC   19030.4 M   207.7 DEG    4.23 M/SEC
  6    1730 CST   4258613N.  733992E.   3451.5 M   197.8 DEG   3.83 M/SEC   22481.9 M   206.2 DEG    4.16 M/SEC
  7    1715 CST   4255052N.  733004E.   3695.0 M   195.5 DEG   4.11 M/SEC   26176.9 M   204.7 DEG    4.16 M/SEC
  8    1700 CST   4251235N.  731741E.   4020.2 M   198.3 DEG   4.47 M/SEC   30197.0 M   203.8 DEG    4.19 M/SEC
  9    1645 CST   4247031N.  731012E.   4265.6 M   189.9 DEG   4.74 M/SEC   34462.6 M   202.1 DEG    4.25 M/SEC
 10    1630 CST   4242623N.  730626E.   4425.6 M   185.0 DEG   4.92 M/SEC   38888.2 M   200.1 DEG    4.32 M/SEC
 11    1615 CST   4238906N.  729782E.   3811.5 M   192.8 DEG   4.24 M/SEC   42699.8 M   199.5 DEG    4.31 M/SEC
 12    1600 CST   4235954N.  728737E.   3132.5 M   199.5 DEG   3.48 M/SEC   45832.3 M   199.5 DEG    4.24 M/SEC
 13    1545 CST   4232947N.  728204E.   3151.8 M   187.7 DEG.  3.50 M/SEC   48984.1 M   198.9 DEG    4.19 M/SEC
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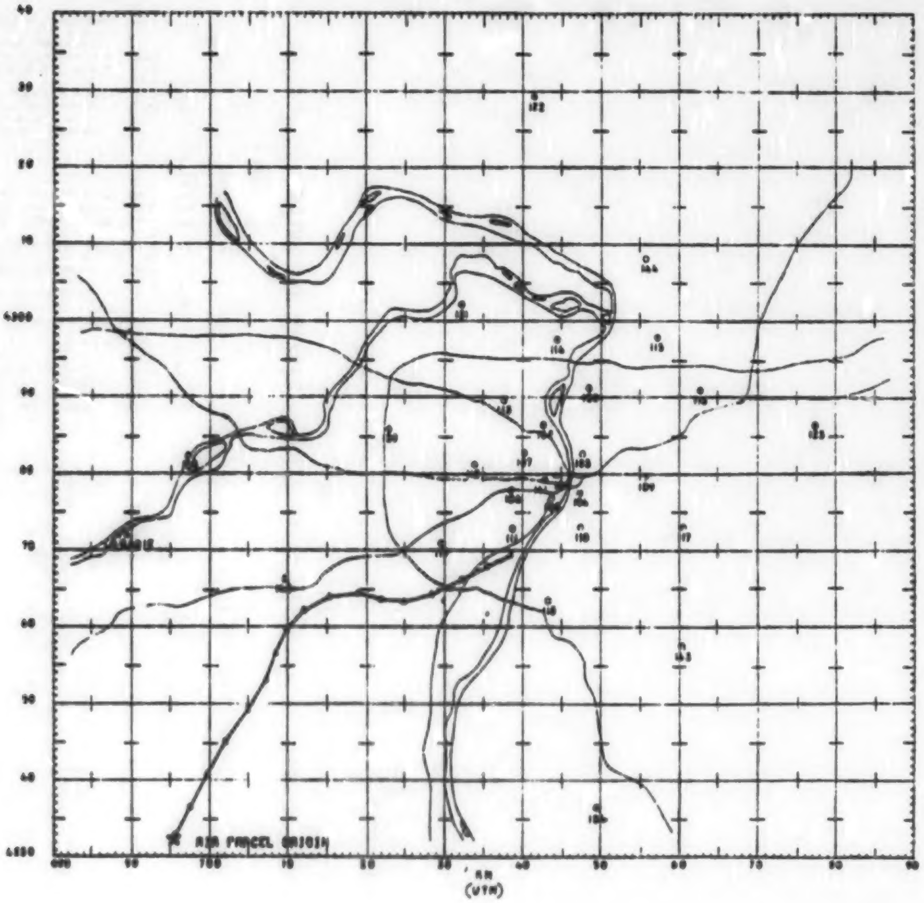

RAMS NEAR-SFC
TRAJECTORY #33
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1900 CST 23 JUL 75
ARRIVING 2300 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-300 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 23 JUL 75  1900 CST      END TIME: 23 JUL 75  2300 CST

     INITIAL COORDINATES: 4269380N. 736500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK

     TRAJECTORY TYPE: BACKWARD IN TIME

     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 16

                                                                                         ACCUMULATED DISPLACEMENT
                                            INCREMENTAL DISPLACEMENT              PATH        AZIMUTH          SPEED
STEP    TIME          LOCATION            RADIAL    AZIMUTH       SPEED          LENGTH   (FROM ORIGIN)   (ALONG PATH)

  0    2300 CST   4269380N. 738500E.         0 M      0 DEG      0 M/SEC             0 M      0 DEG        0 M/SEC
  1    2245 CST   4267956N. 735403E.    3408.3 M  245.3 DEG   3.79 M/SEC       3408.3 M  245.3 DEG     3.79 M/SEC
  2    2230 CST   4266198N. 732192E.    3673.7 M  241.2 DEG   4.08 M/SEC       7082.0 M  243.2 DEG     3.93 M/SEC
  3    2215 CST   4264362N. 728413E.    4187.8 M  244.1 DEG   4.65 M/SEC      11269.8 M  243.6 DEG     4.17 M/SEC
  4    2200 CST   4263371N. 724972E.    3678.2 M  254.4 DEG   4.09 M/SEC      14948.0 M  246.2 DEG     4.15 M/SEC
  5    2145 CST   4263641N. 722429E.    2855.4 M  275.4 DEG   3.17 M/SEC      17803.4 M  250.8 DEG     3.96 M/SEC
  6    2130 CST   4264423N. 719425E.    3104.0 M  284.5 DEG   3.45 M/SEC      20907.4 M  255.7 DEG     3.87 M/SEC
  7    2115 CST   4263993N. 715768E.    3682.3 M  263.3 DEG   4.09 M/SEC      24589.7 M  256.9 DEG     3.90 M/SEC
  8    2100 CST   4262225N. 712510E.    3707.3 M  241.5 DEG   4.12 M/SEC      28297.0 M  254.8 DEG     3.93 M/SEC
  9    2045 CST   4259769N. 710323E.    3288.6 M  221.7 DEG   3.65 M/SEC      31585.6 M  251.4 DEG     3.90 M/SEC
 10    2030 CST   4256759N. 708964E.    3301.9 M  204.3 DEG   3.67 M/SEC      34887.5 M  247.1 DEG     3.88 M/SEC
 11    2015 CST   4253306N. 707245E.    3661.9 M  199.4 DEG   4.07 M/SEC      38549.4 M  242.7 DEG     3.89 M/SEC
 12    2000 CST   4249397N. 704566E.    4576.5 M  211.3 DEG   5.09 M/SEC      43125.9 M  239.2 DEG     3.99 M/SEC
 13    1945 CST   4245273N. 702093E.    5025.5 M  214.9 DEG   5.58 M/SEC      48151.4 M  236.5 DEG     4.12 M/SEC
 14    1930 CST   4241039N. 699797E.    4813.8 M  208.5 DEG   5.35 M/SEC      52965.2 M  233.8 DEG     4.20 M/SEC
 15    1915 CST   4236749N. 697583E.    4825.7 M  207.3 DEG   5.36 M/SEC      57793.9 M  231.4 DEG     4.28 M/SEC
 16    1900 CST   4232726N. 695476E.    4543.6 M  207.7 DEG   5.05 M/SEC      62337.5 M  229.6 DEG     4.33 M/SEC
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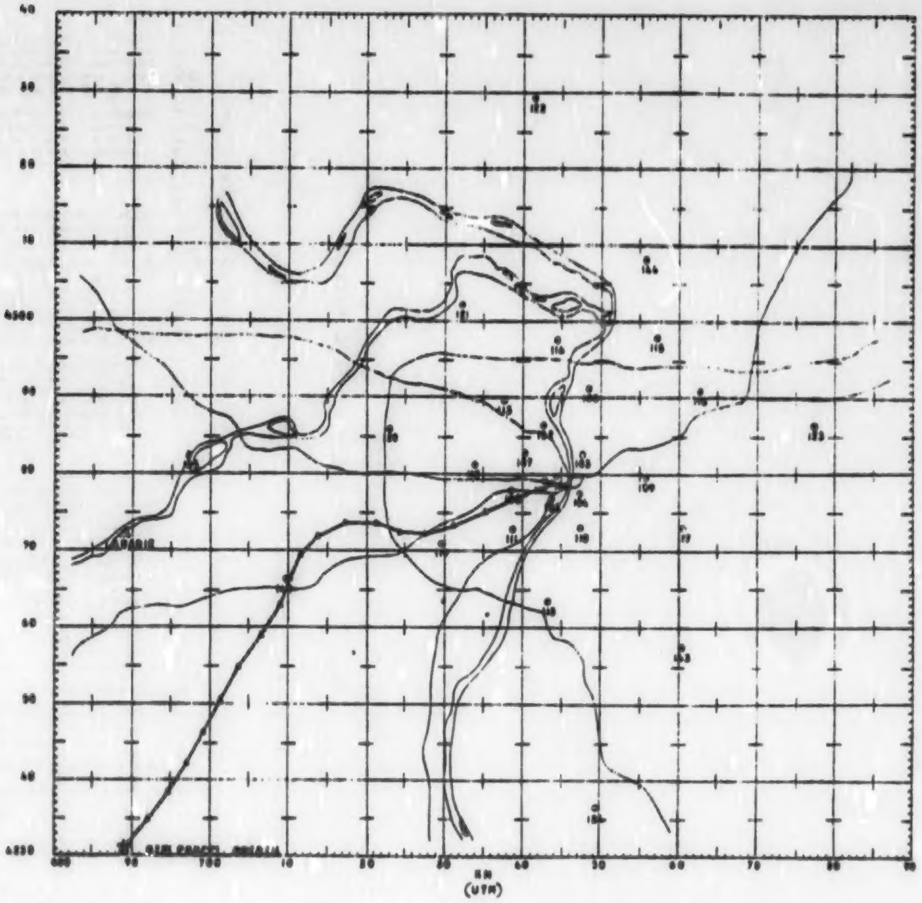

RAMS NEAR-SFC
TRAJECTORY #34
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1815 CST 23 JUL 75
ARRIVING 2300 CST 23 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 23 JUL 75  1815 CST     END TIME: 23 JUL 75  2300 CST
    INITIAL COORDINATES: 4278750N. 743880E.     LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN            NUMBER OF STEPS: 19

                                                                                  ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT        PATH      AZIMUTH        SPEED
STEP   TIME          LOCATION           RADIAL    AZIMUTH       SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)
  0    2300 CST  4278750N.  743880E.        0 M        0 DEG       0 M/SEC        0 M       0 DEG        0 M/SEC
  1    2245 CST  4276927N.  739515E.   4729.7 M   247.3 DEG    5.26 M/SEC    4729.7 M   247.3 DEG     5.26 M/SEC
  2    2230 CST  4275003N.  735330E.   4605.9 M   245.3 DEG    5.12 M/SEC    9335.7 M   246.3 DEG     5.19 M/SEC
  3    2215 CST  4273193N.  731283E.   4433.7 M   245.9 DEG    4.93 M/SEC   13769.4 M   246.2 DEG     5.10 M/SEC
  4    2200 CST  4272095N.  727340E.   3901.8 M   252.6 DEG    4.34 M/SEC   17671.2 M   247.8 DEG     4.91 M/SEC
  5    2145 CST  4272331N.  724503E.   3046.9 M   274.5 DEG    3.39 M/SEC   20718.1 M   251.7 DEG     4.60 M/SEC
  6    2130 CST  4272499N.  721397E.   3315.1 M   290.4 DEG    3.68 M/SEC   24033.2 M   256.8 DEG     4.45 M/SEC
  7    2115 CST  4273494N.  717415E.   3980.3 M   276.1 DEG    4.42 M/SEC   28013.5 M   258.8 DEG     4.45 M/SEC
  8    2100 CST  4271793N.  713549E.   3862.0 M   263.9 DEG    4.29 M/SEC   31875.4 M   256.9 DEG     4.43 M/SEC
  9    2045 CST  4269327N.  711742E.   3302.5 M   221.9 DEG    3.67 M/SEC   35177.9 M   253.7 DEG     4.34 M/SEC
 10    2030 CST  4266315N.  710372E.   3317.8 M   204.4 DEG    3.69 M/SEC   38495.7 M   249.6 DEG     4.28 M/SEC
 11    2015 CST  4262842N.  709147E.   3682.6 M   199.4 DEG    4.09 M/SEC   42178.3 M   245.4 DEG     4.26 M/SEC
 12    2000 CST  4259336N.  706760E.   4578.2 M   211.4 DEG    5.09 M/SEC   46756.4 M   241.9 DEG     4.33 M/SEC
 13    1945 CST  4254836N.  703881E.   5009.0 M   215.1 DEG    5.57 M/SEC   51765.4 M   239.1 DEG     4.42 M/SEC
 14    1930 CST  4250616N.  701591E.   4802.2 M   208.5 DEG    5.34 M/SEC   56567.6 M   236.4 DEG     4.49 M/SEC
 15    1915 CST  4246334N.  699234E.   4812.2 M   207.2 DEG    5.35 M/SEC   61379.8 M   233.9 DEG     4.55 M/SEC
 16    1900 CST  4242317N.  697289E.   4535.7 M   207.7 DEG    5.04 M/SEC   65915.5 M   232.0 DEG     4.58 M/SEC
 17    1845 CST  4239577N.  694935E.   4418.4 M   212.2 DEG    4.91 M/SEC   70333.9 M   230.6 DEG     4.60 M/SEC
 18    1830 CST  4235011N.  692315E.   4425.0 M   216.3 DEG    4.92 M/SEC   74758.9 M   229.7 DEG     4.61 M/SEC
 19    1815 CST  4231322N.  689235E.   4767.6 M   219.3 DEG    5.30 M/SEC   79526.4 M   229.0 DEG     4.65 M/SEC
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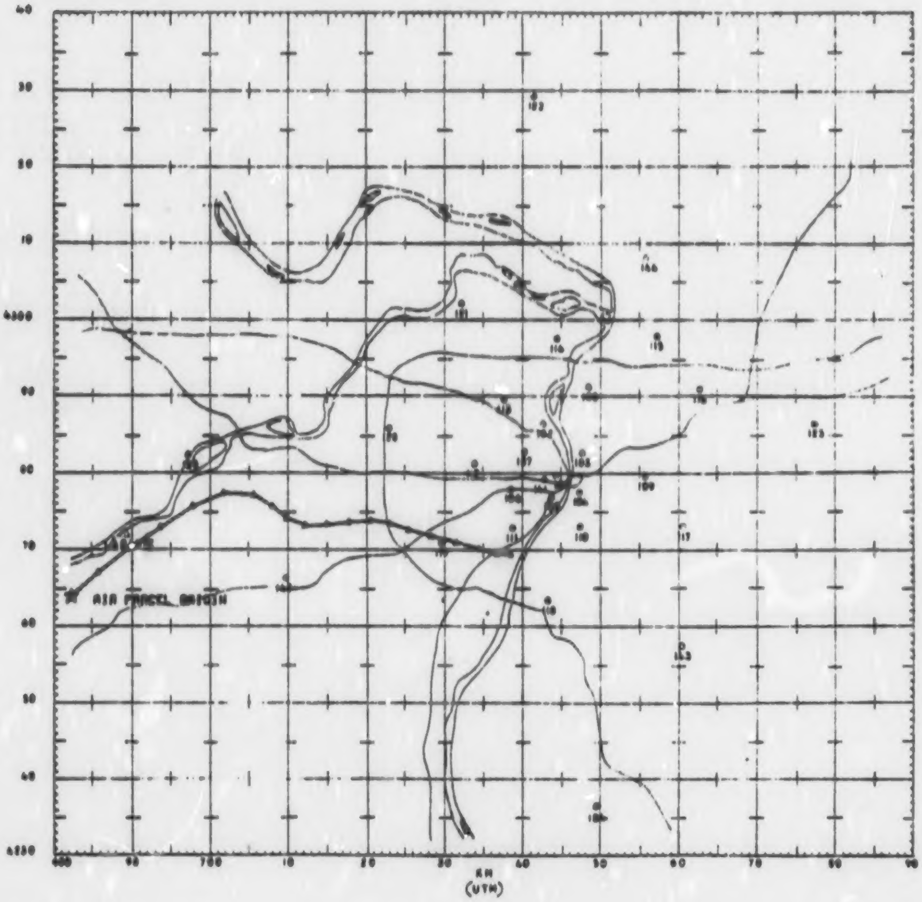
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(UTM)
AIR PARCEL ORIGIN

RAMS NEAR-SFC
TRAJECTORY #35
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 2215 CST 23 JUL 75
ARRIVING 300 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 23 JUL 75   2215 CST       END TIME: 24 JUL 75    300 CST

     INITIAL COORDINATES: 4269380N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK

     TRAJECTORY TYPE: BACKWARD IN TIME

     STEP INTERVAL:  15 MIN              NUMBER OF STEPS: 19

                                                                                     ACCUMULATED DISPLACEMENT
                                             INCREMENTAL DISPLACEMENT           PATH       AZIMUTH         SPEED
                                                                                LENGTH   (FROM ORIGIN)  (ALONG PATH)
                     LOCATION              RADIAL    AZIMUTH      SPEED
STEP   TIME

  0     300 CST  4269380N.  738500E.        0 M        0 DEG      0 M/SEC         0 M        0 DEG       0 M/SEC
  1     245 CST  4269460N.  736662E.   1839.0 M    272.5 DEG   2.04 M/SEC    1839.0 M    272.5 DEG    2.04 M/SEC
  2     230 CST  4270098N.  734370E.   2376.2 M    285.3 DEG   2.64 M/SEC    4215.3 M    279.7 DEG    2.34 M/SEC
  3     215 CST  4270925N.  731476E.   3013.5 M    286.2 DEG   3.35 M/SEC    7228.8 M    282.4 DEG    2.68 M/SEC
  4     200 CST  4271752N.  728366E.   3275.6 M    284.6 DEG   3.64 M/SEC   10504.3 M    283.1 DEG    2.92 M/SEC
  5     145 CST  4272647N.  725430E.   2989.4 M    285.8 DEG   3.32 M/SEC   13493.7 M    283.7 DEG    3.00 M/SEC
  6     130 CST  4273380N.  723035E.   2532.4 M    288.9 DEG   2.81 M/SEC   16026.1 M    284.5 DEG    2.97 M/SEC
  7     115 CST  4273777N.  720346E.   2471.6 M    279.0 DEG   2.75 M/SEC   18497.8 M    283.8 DEG    2.94 M/SEC
  8     100 CST  4273583N.  717817E.   2783.8 M    266.0 DEG   3.09 M/SEC   21281.6 M    281.5 DEG    2.96 M/SEC
  9      45 CST  4273284N.  715003E.   2829.4 M    263.9 DEG   3.14 M/SEC   24111.0 M    279.4 DEG    2.98 M/SEC
 10      30 CST  4273119N.  712282E.   2726.5 M    266.5 DEG   3.03 M/SEC   26837.5 M    278.1 DEG    2.98 M/SEC
 11      15 CST  4274040N.  709923E.   2532.2 M    291.3 DEG   2.81 M/SEC   29369.7 M    279.3 DEG    2.97 M/SEC
 12       0 CST  4275643N.  708096E.   2430.3 M    311.3 DEG   2.70 M/SEC   31800.0 M    281.6 DEG    2.94 M/SEC
 13    2345 CST  4277072N.  705738E.   2750.9 M    301.2 DEG   3.06 M/SEC   34550.9 M    283.2 DEG    2.95 M/SEC
 14    2330 CST  4277346N.  701949E.   3799.1 M    274.1 DEG   4.22 M/SEC   38350.0 M    282.3 DEG    3.04 M/SEC
 15    2315 CST  4275634N.  697993E.   4309.2 M    246.5 DEG   4.79 M/SEC   42659.2 M    278.8 DEG    3.16 M/SEC
 16    2300 CST  4272866N.  693865E.   4969.0 M    236.2 DEG   5.52 M/SEC   47633.2 M    274.5 DEG    3.31 M/SEC
 17    2245 CST  4269954N.  689666E.   5110.1 M    235.3 DEG   5.68 M/SEC   52743.3 M    270.7 DEG    3.45 M/SEC
 18    2230 CST  4267013N.  685970E.   4723.1 M    231.5 DEG   5.25 M/SEC   57466.4 M    267.4 DEG    3.55 M/SEC
 19    2215 CST  4263916N.  682501E.   4651.0 M    228.2 DEG   5.17 M/SEC   62117.4 M    264.4 DEG    3.63 M/SEC
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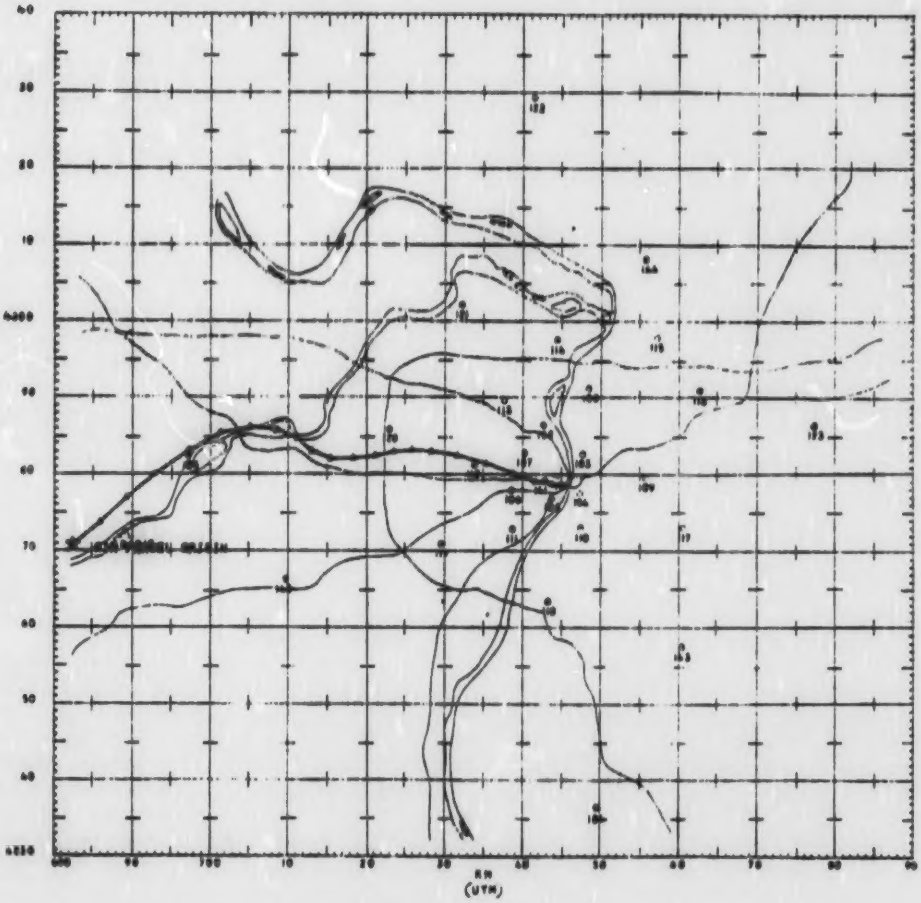
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RAMS NEAR-SFC
TRAJECTORY #36
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 2200 CST 23 JUL 75
ARRIVING 300 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 23 JUL 75   2200 CST      END TIME: 24 JUL 75   300 CST
     INITIAL COORDINATES: 4278750N. 743980E.      LOCATION DESCRIPTOR: 14TH AND MARKET
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN            NUMBER OF STEPS: 20

                                                                                   ACCUMULATED DISPLACEMENT
                                          INCREMENTAL DISPLACEMENT           PATH        AZIMUTH          SPEED
STEP   TIME         LOCATION           RADIAL    AZIMUTH      SPEED        LENGTH   (FROM ORIGIN)  (ALONG PATH)

  0    300 CST  4278750N. 743980E.        0 M      0 DEG      0 M/SEC          0 M      0 DEG        0 M/SEC
  1    245 CST  4279079N. 741700E.   2203.9 M  278.6 DEG   2.45 M/SEC     2203.9 M  278.6 DEG     2.45 M/SEC
  2    230 CST  4280173N. 738907E.   3001.3 M  291.4 DEG   3.33 M/SEC     5205.1 M  286.0 DEG     2.89 M/SEC
  3    215 CST  4281473N. 735499E.   3655.3 M  290.8 DEG   4.06 M/SEC     8860.4 M  288.0 DEG     3.28 M/SEC
  4    200 CST  4282469N. 731827E.   3795.3 M  285.2 DEG   4.22 M/SEC    12655.7 M  287.1 DEG     3.52 M/SEC
  5    145 CST  4283019N. 728534E.   3338.7 M  279.5 DEG   3.71 M/SEC    15994.4 M  285.5 DEG     3.55 M/SEC
  6    130 CST  4283237N. 726048E.   2495.5 M  275.0 DEG   2.77 M/SEC    18489.9 M  284.1 DEG     3.42 M/SEC
  7    115 CST  4283027N. 723749E.   2308.2 M  264.8 DEG   2.56 M/SEC    20798.0 M  282.0 DEG     3.30 M/SEC
  8    100 CST  4282471N. 721364E.   2449.3 M  256.9 DEG   2.72 M/SEC    23247.3 M  279.4 DEG     3.23 M/SEC
  9     45 CST  4282173N. 718525E.   2854.3 M  264.0 DEG   3.17 M/SEC    26101.6 M  277.7 DEG     3.22 M/SEC
 10     30 CST  4282281N. 716645E.   2882.0 M  268.2 DEG   3.20 M/SEC    28983.6 M  276.7 DEG     3.22 M/SEC
 11     15 CST  4283005N. 713384E.   2535.6 M  291.4 DEG   2.82 M/SEC    31519.2 M  277.9 DEG     3.18 M/SEC
 12      0 CST  4284642N. 711440E.   2465.3 M  311.6 DEG   2.74 M/SEC    33984.5 M  280.3 DEG     3.15 M/SEC
 13   2345 CST  4285802N. 709827E.   2858.7 M  293.9 DEG   3.18 M/SEC    36843.2 M  281.9 DEG     3.15 M/SEC
 14   2330 CST  4285112N. 705377E.   3464.3 M  275.1 DEG   3.85 M/SEC    40307.4 M  280.8 DEG     3.20 M/SEC
 15   2315 CST  4285379N. 701622E.   3825.7 M  259.0 DEG   4.25 M/SEC    44133.1 M  278.9 DEG     3.27 M/SEC
 16   2300 CST  4283092N. 697770E.   4653.4 M  240.6 DEG   5.17 M/SEC    48786.5 M  275.4 DEG     3.39 M/SEC
 17   2245 CST  4280002N. 693318E.   5255.0 M  234.0 DEG   5.84 M/SEC    54041.5 M  271.4 DEG     3.53 M/SEC
 18   2230 CST  4276923N. 689671E.   4773.7 M  229.8 DEG   5.30 M/SEC    58815.2 M  268.1 DEG     3.63 M/SEC
 19   2215 CST  4273697N. 686340E.   4636.8 M  225.9 DEG   5.15 M/SEC    63452.0 M  265.0 DEG     3.71 M/SEC
 20   2200 CST  4272773N. 682774E.   4611.7 M  230.7 DEG   5.12 M/SEC    68063.8 M  262.6 DEG     3.78 M/SEC
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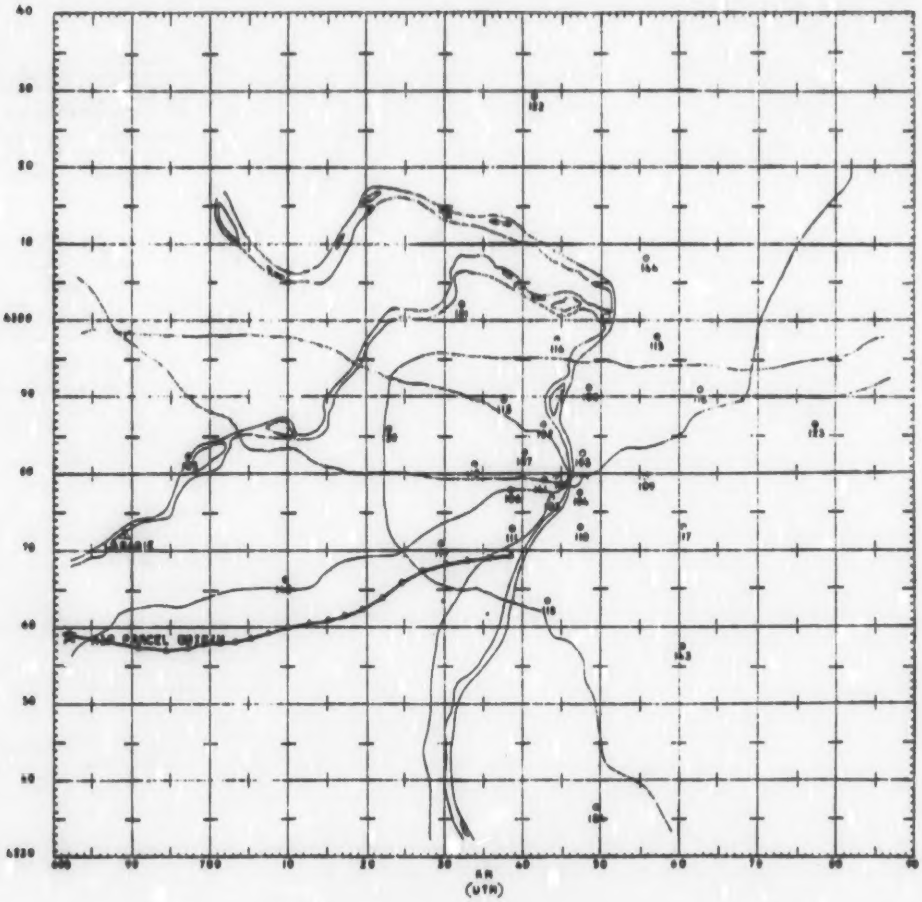
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RAMS NEAR-SFC
TRAJECTORY #37
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 145 CST 24 JUL 75
ARRIVING 700 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 24 JUL 75   145 CST      END TIME: 24 JUL 75   700 CST
     INITIAL COORDINATES: 4269390N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 21

                                                                                       ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT
                                                                                PATH       AZIMUTH          SPEED
 STEP   TIME         LOCATION             RADIAL    AZIMUTH       SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

   0    700 CST  4269390N.  738500E.        0 M       0 DEG      0 M/SEC            0 M      0 DEG       0 M/SEC
   1    645 CST  4269096N.  735701E.   2813.0 M   264.2 DEG   3.13 M/SEC       2813.0 M  264.2 DEG    3.13 M/SEC
   2    630 CST  4268765N.  732915E.   2804.4 M   263.3 DEG   3.12 M/SEC       5617.5 M  263.8 DEG    3.12 M/SEC
   3    615 CST  4268297N.  730156E.   2799.3 M   260.3 DEG   3.11 M/SEC       8416.9 M  262.6 DEG    3.12 M/SEC
   4    600 CST  4267425N.  727256E.   3028.9 M   253.3 DEG   3.37 M/SEC      11445.8 M  260.1 DEG    3.18 M/SEC
   5    545 CST  4265896N.  724529E.   3126.4 M   240.7 DEG   3.47 M/SEC      14572.0 M  256.0 DEG    3.24 M/SEC
   6    530 CST  4263939N.  722051E.   3157.7 M   231.7 DEG   3.51 M/SEC      17729.7 M  251.7 DEG    3.28 M/SEC
   7    515 CST  4262420N.  719567E.   2911.0 M   238.6 DEG   3.23 M/SEC      20640.7 M  249.9 DEG    3.28 M/SEC
   8    500 CST  4261595N.  717280E.   2431.2 M   250.2 DEG   2.70 M/SEC      23071.8 M  249.9 DEG    3.20 M/SEC
   9    445 CST  4261018N.  715159E.   2159.7 M   254.5 DEG   2.40 M/SEC      25231.5 M  250.3 DEG    3.12 M/SEC
  10    430 CST  4260519N.  712751E.   2490.7 M   260.9 DEG   2.76 M/SEC      27712.2 M  251.2 DEG    3.08 M/SEC
  11    415 CST  4260101N.  710022E.   2777.5 M   259.2 DEG   3.09 M/SEC      30489.7 M  252.0 DEG    3.08 M/SEC
  12    400 CST  4259341N.  707523E.   2612.4 M   253.1 DEG   2.90 M/SEC      33102.2 M  252.0 DEG    3.07 M/SEC
  13    345 CST  4258717N.  705297E.   2311.2 M   254.4 DEG   2.57 M/SEC      35413.4 M  252.2 DEG    3.03 M/SEC
  14    330 CST  4258179N.  703315E.   2053.7 M   254.6 DEG   2.28 M/SEC      37467.0 M  252.3 DEG    2.97 M/SEC
  15    315 CST  4258062N.  701477E.   1841.5 M   266.4 DEG   2.05 M/SEC      39309.5 M  253.0 DEG    2.91 M/SEC
  16    300 CST  4257932N.  699539E.   1944.0 M   266.2 DEG   2.16 M/SEC      41252.6 M  253.6 DEG    2.86 M/SEC
  17    245 CST  4257382N.  697328E.   2277.1 M   256.0 DEG   2.53 M/SEC      43529.6 M  253.9 DEG    2.85 M/SEC
  18    230 CST  4257088N.  694532E.   2812.0 M   264.0 DEG   3.12 M/SEC      46341.6 M  254.4 DEG    2.86 M/SEC
  19    215 CST  4257361N.  690980E.   3562.6 M   274.4 DEG   3.96 M/SEC      49904.1 M  255.3 DEG    2.92 M/SEC
  20    200 CST  4258167N.  686833E.   4224.0 M   281.0 DEG   4.69 M/SEC      54128.2 M  257.8 DEG    3.01 M/SEC
  21    145 CST  4259967N.  682197E.   4704.9 M   279.8 DEG   5.23 M/SEC      58833.1 M  259.5 DEG    3.11 M/SEC
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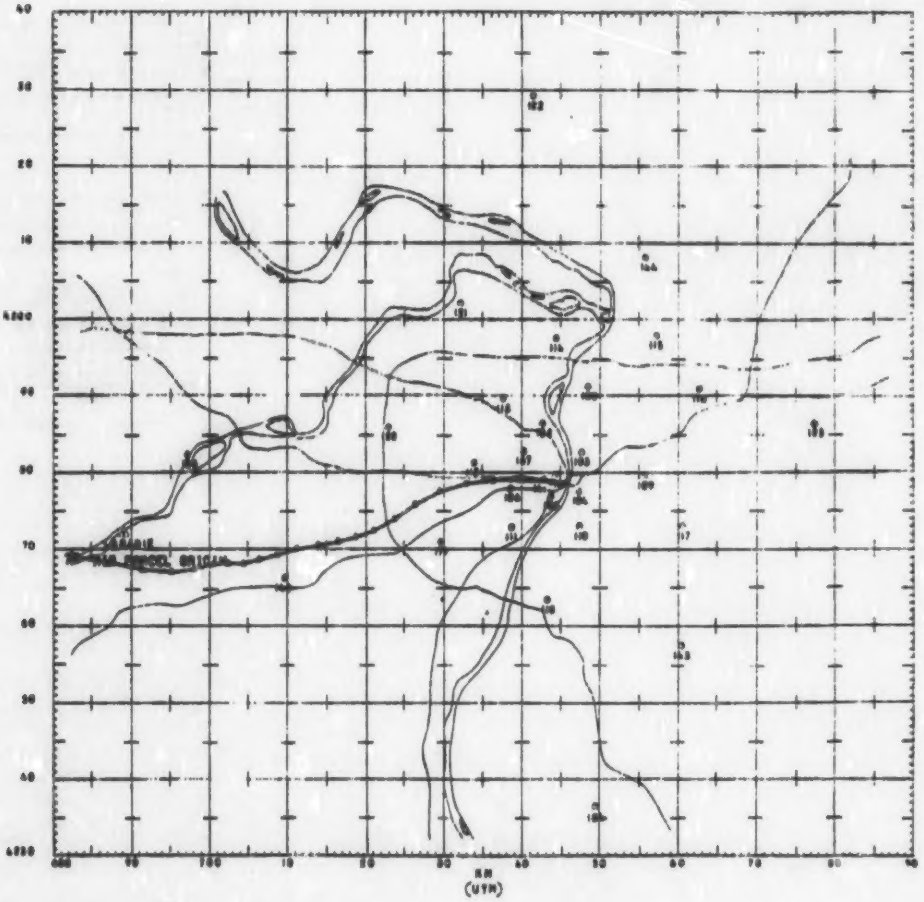
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90
KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #38
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 145 CST 24 JUL 75
ARRIVING 700 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
PAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 24 JUL 75    145 CST      END TIME: 24 JUL 75   700 CST
     INITIAL COORDINATES: 4278750N. 743880E.      LOCATION DESCRIPTOR: 14TH AND MARKET
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN           NUMBER OF STEPS: 21

                                       INCREMENTAL DISPLACEMENT                  ACCUMULATED DISPLACEMENT
 STEP   TIME         LOCATION          RADIAL   AZIMUTH      SPEED          PATH       AZIMUTH         SPEED
                                                                           LENGTH  (FROM ORIGIN)  (ALONG PATH)
   0    700 CST  4278750N.  743880E.       0 M       0 DEG     0 M/SEC          0 M       0 DEG       0 M/SEC
   1    645 CST  4278972N.  740121E.  3765.2 M   273.4 DEG  4.18 M/SEC     3765.2 M   273.4 DEG    4.18 M/SEC
   2    630 CST  4278933N.  736415E.  3706.1 M   269.4 DEG  4.12 M/SEC     7471.2 M   271.4 DEG    4.15 M/SEC
   3    615 CST  4278533N.  732974E.  3464.5 M   263.4 DEG  3.85 M/SEC    10935.7 M   268.9 DEG    4.05 M/SEC
   4    600 CST  4277483N.  729561E.  3571.0 M   252.9 DEG  3.97 M/SEC    14506.7 M   264.9 DEG    4.03 M/SEC
   5    545 CST  4275784N.  726439E.  3554.1 M   241.4 DEG  3.95 M/SEC    18060.8 M   260.3 DEG    4.01 M/SEC
   6    530 CST  4273865N.  723772E.  3284.6 M   234.3 DEG  3.65 M/SEC    21345.4 M   256.3 DEG    3.95 M/SEC
   7    515 CST  4272404N.  721174E.  2981.4 M   240.6 DEG  3.31 M/SEC    24326.8 M   254.4 DEG    3.86 M/SEC
   8    500 CST  4271545N.  718844E.  2483.0 M   249.7 DEG  2.76 M/SEC    26809.7 M   253.9 DEG    3.72 M/SEC
   9    445 CST  4270983N.  716592E.  2321.3 M   256.0 DEG  2.58 M/SEC    29131.0 M   254.1 DEG    3.60 M/SEC
  10    430 CST  4270506N.  714098E.  2539.5 M   259.2 DEG  2.82 M/SEC    31670.5 M   254.5 DEG    3.52 M/SEC
  11    415 CST  4270004N.  711353E.  2793.5 M   259.6 DEG  3.10 M/SEC    34461.1 M   255.0 DEG    3.48 M/SEC
  12    400 CST  4269255N.  709532E.  2628.2 M   253.5 DEG  2.92 M/SEC    37089.3 M   254.8 DEG    3.43 M/SEC
  13    345 CST  4268641N.  706573E.  2342.1 M   254.7 DEG  2.60 M/SEC    39431.3 M   254.8 DEG    3.37 M/SEC
  14    330 CST  4268117N.  704554E.  2083.7 M   255.5 DEG  2.32 M/SEC    41517.0 M   254.9 DEG    3.30 M/SEC
  15    315 CST  4268088N.  702660E.  1894.3 M   269.1 DEG  2.10 M/SEC    43411.4 M   255.5 DEG    3.22 M/SEC
  16    300 CST  4267994N.  700621E.  2041.9 M   267.3 DEG  2.27 M/SEC    45453.2 M   256.0 DEG    3.16 M/SEC
  17    245 CST  4267362N.  698311E.  2395.0 M   254.7 DEG  2.66 M/SEC    47848.2 M   256.0 DEG    3.13 M/SEC
  18    230 CST  4266984N.  695398E.  2936.6 M   262.6 DEG  3.26 M/SEC    50784.3 M   256.4 DEG    3.13 M/SEC
  19    215 CST  4267227N.  691734E.  3672.3 M   273.8 DEG  4.08 M/SEC    54457.1 M   257.5 DEG    3.18 M/SEC
  20    200 CST  4268065N.  687466E.  4350.4 M   281.2 DEG  4.83 M/SEC    58807.6 M   259.3 DEG    3.27 M/SEC
  21    145 CST  4268892N.  682655E.  4881.1 M   279.7 DEG  5.42 M/SEC    63686.7 M   260.9 DEG    3.37 M/SEC
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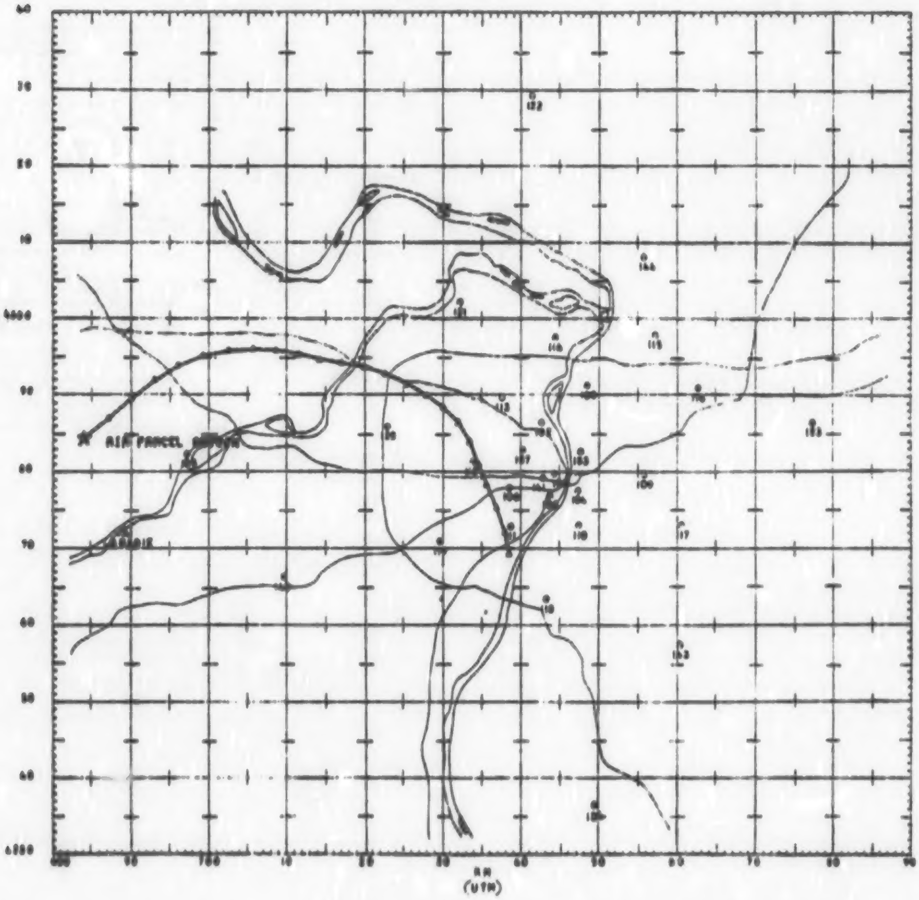

RAMS NEAR-SFC
TRAJECTORY #39
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 515 CST 24 JUL 75
ARRIVING 1100 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 24 JUL 75   515 CST     END TIME: 24 JUL 75  1100 CST

    INITIAL COORDINATES: 4269380N. 738500E.     LOCATION DESCRIPTOR: BROADWAY AND HURCK

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN         NUMBER OF STEPS: 23

                                                                                    ACCUMULATED DISPLACEMENT
                                          INCREMENTAL DISPLACEMENT  --------------------------------------------------
                                                                         PATH       AZIMUTH          SPEED
STEP   TIME         LOCATION          RADIAL   AZIMUTH      SPEED       LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    1100 CST  4269380N. 738500E.       0 M      0 DEG      0 M/SEC        0 M      0 DEG       0 M/SEC
  1    1045 CST  4272143N. 737966E.  2814.6 M  349.1 DEG   3.13 M/SEC   2814.6 M  349.1 DEG    3.13 M/SEC
  2    1030 CST  4275380N. 736915E.  3403.7 M  342.0 DEG   3.78 M/SEC   6218.3 M  345.2 DEG    3.45 M/SEC
  3    1015 CST  4278355N. 735626E.  3242.0 M  336.6 DEG   3.60 M/SEC   9460.3 M  342.2 DEG    3.50 M/SEC
  4    1000 CST  4281028N. 734560E.  2877.1 M  338.2 DEG   3.20 M/SEC  12337.4 M  341.3 DEG    3.43 M/SEC
  5     945 CST  4283965N. 733529E.  3018.6 M  340.0 DEG   3.35 M/SEC  15356.0 M  341.1 DEG    3.41 M/SEC
  6     930 CST  4286518N. 732062E.  2944.9 M  330.1 DEG   3.27 M/SEC  18300.9 M  339.3 DEG    3.39 M/SEC
  7     915 CST  4288391N. 730129E.  2754.7 M  315.7 DEG   3.06 M/SEC  21055.6 M  336.3 DEG    3.34 M/SEC
  8     900 CST  4289990N. 727964E.  2669.9 M  306.5 DEG   2.97 M/SEC  23725.5 M  333.0 DEG    3.30 M/SEC
  9     845 CST  4291432N. 725413E.  2961.4 M  299.4 DEG   3.29 M/SEC  26686.9 M  329.3 DEG    3.29 M/SEC
 10     830 CST  4292737N. 722683E.  3025.8 M  295.6 DEG   3.36 M/SEC  29712.7 M  325.9 DEG    3.30 M/SEC
 11     815 CST  4293699N. 720030E.  2822.2 M  289.9 DEG   3.14 M/SEC  32534.9 M  322.8 DEG    3.29 M/SEC
 12     800 CST  4294191N. 717175E.  2897.0 M  279.8 DEG   3.22 M/SEC  35431.9 M  319.3 DEG    3.28 M/SEC
 13     745 CST  4294622N. 714409E.  2799.3 M  278.9 DEG   3.11 M/SEC  38231.2 M  316.3 DEG    3.27 M/SEC
 14     730 CST  4295269N. 711733E.  2753.4 M  293.6 DEG   3.06 M/SEC  40984.6 M  314.0 DEG    3.25 M/SEC
 15     715 CST  4295789N. 708873E.  2909.3 M  280.3 DEG   3.23 M/SEC  43893.9 M  311.7 DEG    3.25 M/SEC
 16     700 CST  4295954N. 705893E.  2981.9 M  273.2 DEG   3.31 M/SEC  46875.8 M  309.2 DEG    3.26 M/SEC
 17     645 CST  4295765N. 702775E.  3123.4 M  266.5 DEG   3.47 M/SEC  49999.2 M  306.4 DEG    3.27 M/SEC
 18     630 CST  4295120N. 699526E.  3333.3 M  259.8 DEG   3.70 M/SEC  53332.5 M  303.4 DEG    3.29 M/SEC
 19     615 CST  4293309N. 696324E.  3437.9 M  247.6 DEG   3.82 M/SEC  56769.4 M  300.1 DEG    3.32 M/SEC
 20     600 CST  4291914N. 693237E.  3540.0 M  237.7 DEG   3.93 M/SEC  60309.4 M  296.5 DEG    3.35 M/SEC
 21     545 CST  4289555N. 690405E.  3762.6 M  231.2 DEG   4.18 M/SEC  64072.0 M  292.8 DEG    3.39 M/SEC
 22     530 CST  4286903N. 687393E.  4014.4 M  228.6 DEG   4.46 M/SEC  68086.3 M  288.9 DEG    3.44 M/SEC
 23     515 CST  4284363N. 684300E.  4001.7 M  230.6 DEG   4.45 M/SEC  72087.9 M  285.5 DEG    3.48 M/SEC
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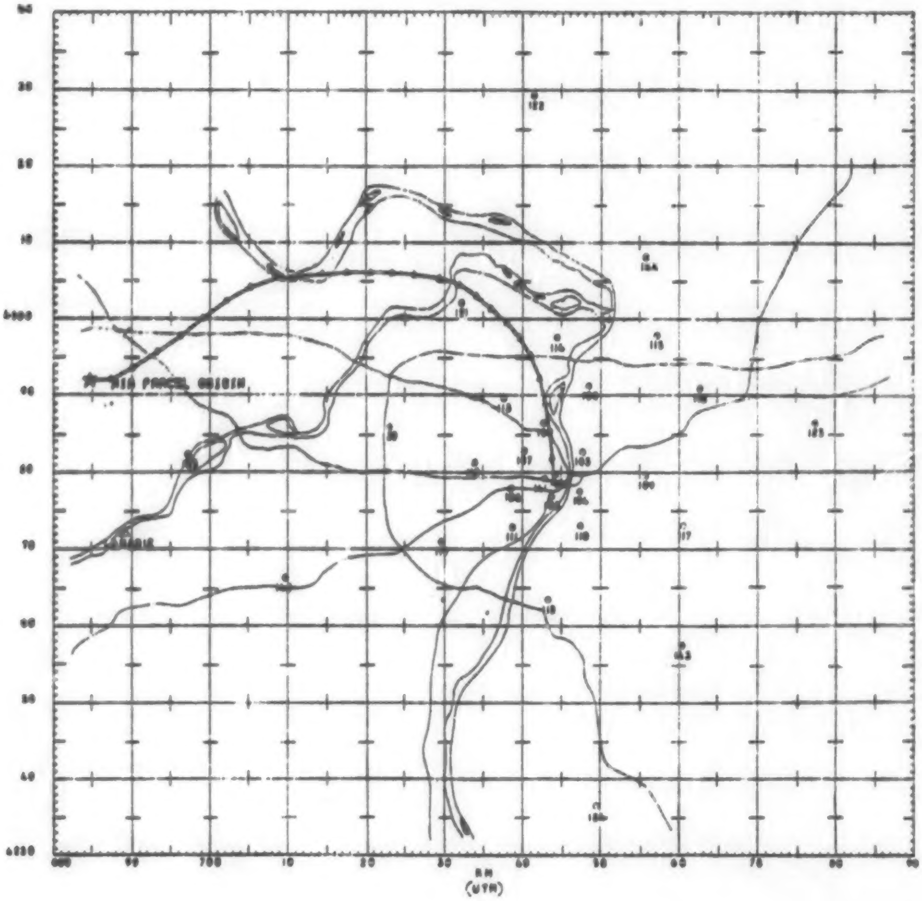
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AIR PARCEL ORIGIN
KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #40
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 430 CST 24 JUL 75
ARRIVING 1100 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 24 JUL 75   430 CST     END TIME: 24 JUL 75  1100 CST
     INITIAL COORDINATES: 4278750N. 743880E.     LOCATION DESCRIPTION: 14TH AND MARKET
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL: 15 MIN            NUMBER OF STEPS: 26

                                                                              ACCUMULATED DISPLACEMENT
                                          INCREMENTAL DISPLACEMENT
                                                                        PATH       AZIMUTH          SPEED
STEP   TIME        LOCATION           RADIAL    AZIMUTH      SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0   1100 CST  4278750N. 743880E.       0 M      0 DEG      0 M/SEC        0 M      0 DEG        0 M/SEC
  1   1045 CST  4281860N. 743733E.  3113.7 M  357.3 DEG   3.46 M/SEC   3113.7 M  357.3 DEG     3.46 M/SEC
  2   1030 CST  4285331N. 743369E.  3488.5 M  354.3 DEG   3.88 M/SEC   6602.2 M  355.7 DEG     3.67 M/SEC
  3   1015 CST  4288969N. 742889E.  3672.3 M  352.2 DEG   4.08 M/SEC  10274.4 M  354.5 DEG     3.81 M/SEC
  4   1000 CST  4292290N. 742177E.  3396.7 M  347.9 DEG   3.77 M/SEC  13671.1 M  352.8 DEG     3.80 M/SEC
  5    945 CST  4295172N. 741075E.  3084.4 M  339.1 DEG   3.43 M/SEC  16755.5 M  350.3 DEG     3.72 M/SEC
  6    930 CST  4297534N. 739706E.  2730.6 M  329.9 DEG   3.03 M/SEC  19486.1 M  347.5 DEG     3.61 M/SEC
  7    915 CST  4299551N. 737975E.  2657.6 M  319.4 DEG   2.95 M/SEC  22143.7 M  344.2 DEG     3.51 M/SEC
  8    900 CST  4301300N. 736071E.  2585.7 M  312.6 DEG   2.87 M/SEC  24729.5 M  340.9 DEG     3.43 M/SEC
  9    845 CST  4302974N. 734157E.  2542.6 M  311.2 DEG   2.83 M/SEC  27272.0 M  338.1 DEG     3.37 M/SEC
 10    830 CST  4304453N. 732073E.  2555.1 M  305.3 DEG   2.84 M/SEC  29827.1 M  335.3 DEG     3.31 M/SEC
 11    815 CST  4305352N. 729417E.  2804.3 M  298.7 DEG   3.12 M/SEC  32631.4 M  331.5 DEG     3.30 M/SEC
 12    800 CST  4305839N. 726294E.  3160.5 M  278.9 DEG   3.51 M/SEC  35791.9 M  327.0 DEG     3.31 M/SEC
 13    745 CST  4306058N. 723430E.  2873.0 M  274.4 DEG   3.19 M/SEC  38664.9 M  323.2 DEG     3.30 M/SEC
 14    730 CST  4306160N. 720645E.  2785.4 M  272.1 DEG   3.09 M/SEC  41450.4 M  319.7 DEG     3.29 M/SEC
 15    715 CST  4306145N. 717654E.  2991.9 M  269.7 DEG   3.32 M/SEC  44442.2 M  315.2 DEG     3.29 M/SEC
 16    700 CST  4305970N. 714594E.  3075.8 M  266.8 DEG   3.42 M/SEC  47518.0 M  312.9 DEG     3.30 M/SEC
 17    645 CST  4305794N. 711522E.  3066.4 M  266.7 DEG   3.41 M/SEC  50584.3 M  309.9 DEG     3.31 M/SEC
 18    630 CST  4305391N. 708478E.  3071.0 M  262.5 DEG   3.41 M/SEC  53655.4 M  307.0 DEG     3.31 M/SEC
 19    615 CST  4304270N. 705367E.  3306.3 M  250.2 DEG   3.67 M/SEC  56961.6 M  303.5 DEG     3.33 M/SEC
 20    600 CST  4302460N. 702291E.  3569.4 M  239.5 DEG   3.97 M/SEC  60531.0 M  299.7 DEG     3.36 M/SEC
 21    545 CST  4300203N. 699323E.  3728.4 M  232.8 DEG   4.14 M/SEC  64259.4 M  295.7 DEG     3.40 M/SEC
 22    530 CST  4297876N. 696425E.  3717.1 M  231.2 DEG   4.13 M/SEC  67976.5 M  292.0 DEG     3.43 M/SEC
 23    515 CST  4295793N. 693417E.  3658.5 M  235.3 DEG   4.07 M/SEC  71635.0 M  289.7 DEG     3.46 M/SEC
 24    500 CST  4293778N. 690299E.  3712.3 M  237.1 DEG   4.12 M/SEC  75347.3 M  285.7 DEG     3.49 M/SEC
 25    445 CST  4292291N. 687569E.  3109.3 M  241.4 DEG   3.45 M/SEC  78456.5 M  283.5 DEG     3.49 M/SEC
 26    430 CST  4292213N. 684889E.  2680.5 M  268.3 DEG   2.98 M/SEC  81137.0 M  282.9 DEG     3.47 M/SEC
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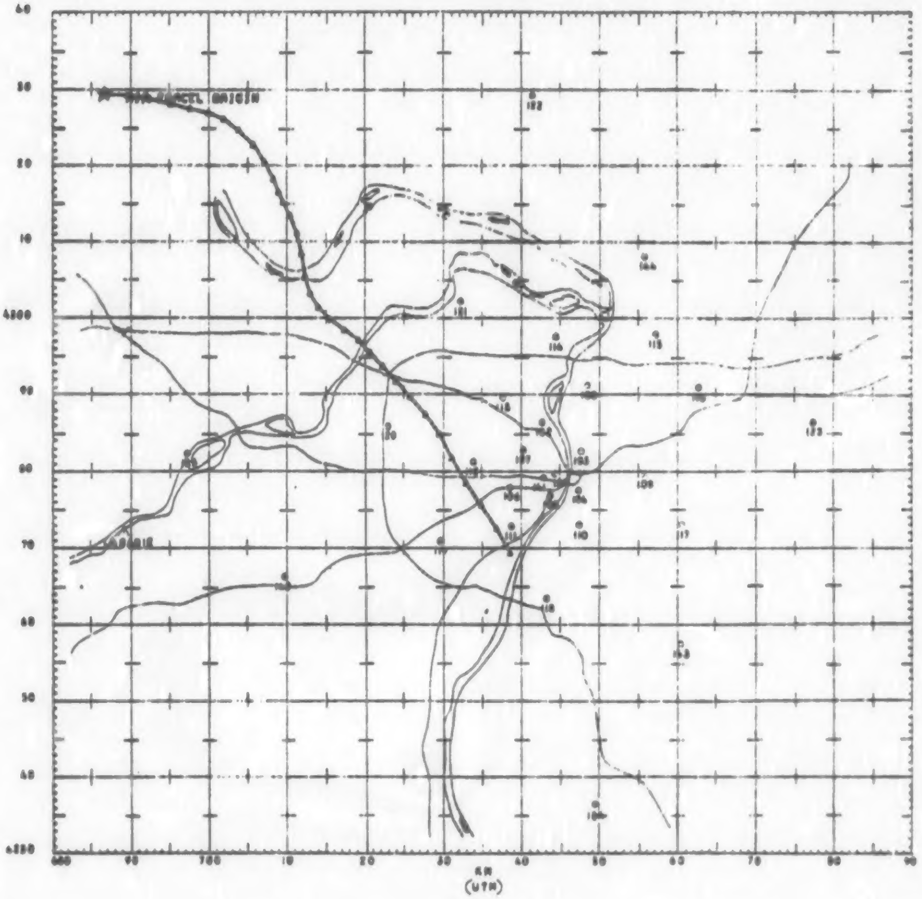
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(UTM)
PARCEL ORIGIN
122
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RAMS NEAR-SFC
TRAJECTORY #41
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 700 CST 24 JUL 75
ARRIVING 1500 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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SAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 24 JUL 75   700 CST      END TIME: 24 JUL 75  1500 CST

     INITIAL COORDINATES: 4269380N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK

     TRAJECTORY TYPE: BACKWARD IN TIME

     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 32

                                                                                    ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT          PATH       AZIMUTH        SPEED
 STEP   TIME         LOCATION             RADIAL    AZIMUTH       SPEED         LENGTH  (FROM ORIGIN)  (ALONG PATH)

   0   1500 CST   4269380N. 738500E.        0 M       0 DEG       0 M/SEC          0 M       0 DEG         0 M/SEC
   1   1445 CST   4272590N. 736752E.   3655.5 M   331.4 DEG    4.06 M/SEC     3655.5 M   331.4 DEG      4.06 M/SEC
   2   1430 CST   4275622N. 734796E.   3608.1 M   327.2 DEG    4.01 M/SEC     7263.6 M   329.3 DEG      4.04 M/SEC
   3   1415 CST   4279471N. 732809E.   3427.9 M   326.2 DEG    3.81 M/SEC    10691.6 M   328.3 DEG      3.96 M/SEC
   4   1400 CST   4281753N. 731088E.   3743.8 M   331.3 DEG    4.16 M/SEC    14435.4 M   329.1 DEG      4.01 M/SEC
   5   1345 CST   4284811N. 729525E.   3429.7 M   333.1 DEG    3.81 M/SEC    17865.1 M   329.8 DEG      3.97 M/SEC
   6   1330 CST   4287379N. 727708E.   3151.9 M   324.6 DEG    3.50 M/SEC    21016.9 M   329.1 DEG      3.89 M/SEC
   7   1315 CST   4289697N. 725745E.   3037.8 M   319.7 DEG    3.38 M/SEC    24054.8 M   327.9 DEG      3.82 M/SEC
   8   1300 CST   4291730N. 723971E.   2697.3 M   318.9 DEG    3.00 M/SEC    26752.1 M   327.0 DEG      3.72 M/SEC
   9   1245 CST   4293635N. 722229E.   2581.5 M   317.6 DEG    2.87 M/SEC    29333.5 M   326.1 DEG      3.62 M/SEC
  10   1230 CST   4295426N. 720613E.   2412.7 M   317.9 DEG    2.68 M/SEC    31746.2 M   325.5 DEG      3.53 M/SEC
  11   1215 CST   4297082N. 719162E.   2202.2 M   318.8 DEG    2.45 M/SEC    33948.4 M   325.1 DEG      3.43 M/SEC
  12   1200 CST   4298355N. 717428E.   2150.8 M   306.3 DEG    2.39 M/SEC    36099.1 M   324.0 DEG      3.34 M/SEC
  13   1145 CST   4299655N. 715591E.   2269.3 M   305.9 DEG    2.52 M/SEC    38367.4 M   322.9 DEG      3.28 M/SEC
  14   1130 CST   4301294N. 714075E.   2209.8 M   316.7 DEG    2.46 M/SEC    40577.2 M   322.6 DEG      3.22 M/SEC
  15   1115 CST   4303109N. 713061E.   2078.4 M   330.9 DEG    2.31 M/SEC    42655.5 M   323.0 DEG      3.16 M/SEC
  16   1100 CST   4305499N. 712411E.   2477.4 M   344.8 DEG    2.75 M/SEC    45133.0 M   324.2 DEG      3.13 M/SEC
  17   1045 CST   4309248N. 711977E.   2783.4 M   351.0 DEG    3.09 M/SEC    47916.4 M   325.7 DEG      3.13 M/SEC
  18   1030 CST   4310763N. 711423E.   2771.3 M   348.5 DEG    3.08 M/SEC    50687.6 M   326.9 DEG      3.13 M/SEC
  19   1015 CST   4313321N. 710493E.   2534.3 M   338.5 DEG    2.82 M/SEC    53222.0 M   327.5 DEG      3.11 M/SEC
  20   1000 CST   4314972N. 709717E.   1824.7 M   334.8 DEG    2.03 M/SEC    55046.6 M   327.7 DEG      3.06 M/SEC
  21    945 CST   4316303N. 709095E.   1469.2 M   335.0 DEG    1.63 M/SEC    56515.9 M   327.9 DEG      2.99 M/SEC
  22    930 CST   4318033N. 708414E.   1859.2 M   338.5 DEG    2.07 M/SEC    58375.0 M   328.3 DEG      2.95 M/SEC
  23    915 CST   4320283N. 707340E.   2492.8 M   334.5 DEG    2.77 M/SEC    60867.8 M   328.5 DEG      2.94 M/SEC
  24    900 CST   4322511N. 705892E.   2657.5 M   327.0 DEG    2.95 M/SEC    63525.3 M   328.5 DEG      2.94 M/SEC
  25    845 CST   4324430N. 704064E.   2650.0 M   316.4 DEG    2.94 M/SEC    66175.3 M   328.0 DEG      2.94 M/SEC
  26    830 CST   4325893N. 702143E.   2414.6 M   307.3 DEG    2.68 M/SEC    68589.8 M   327.2 DEG      2.93 M/SEC
  27    815 CST   4326692N. 700201E.   2099.7 M   292.4 DEG    2.33 M/SEC    70689.4 M   326.2 DEG      2.91 M/SEC
  28    800 CST   4327214N. 697907E.   2353.0 M   282.8 DEG    2.61 M/SEC    73042.4 M   324.9 DEG      2.90 M/SEC
  29    745 CST   4327824N. 695416E.   2564.4 M   283.8 DEG    2.85 M/SEC    75606.8 M   323.6 DEG      2.90 M/SEC
  30    730 CST   4328469N. 692733E.   2759.4 M   293.5 DEG    3.07 M/SEC    78366.1 M   322.2 DEG      2.90 M/SEC
  31    715 CST   4329977N. 689874E.   2904.5 M   290.1 DEG    3.23 M/SEC    81270.6 M   320.8 DEG      2.91 M/SEC
  32    700 CST   4330170N. 685912E.   2967.9 M   273.7 DEG    3.30 M/SEC    84238.4 M   319.2 DEG      2.92 M/SEC
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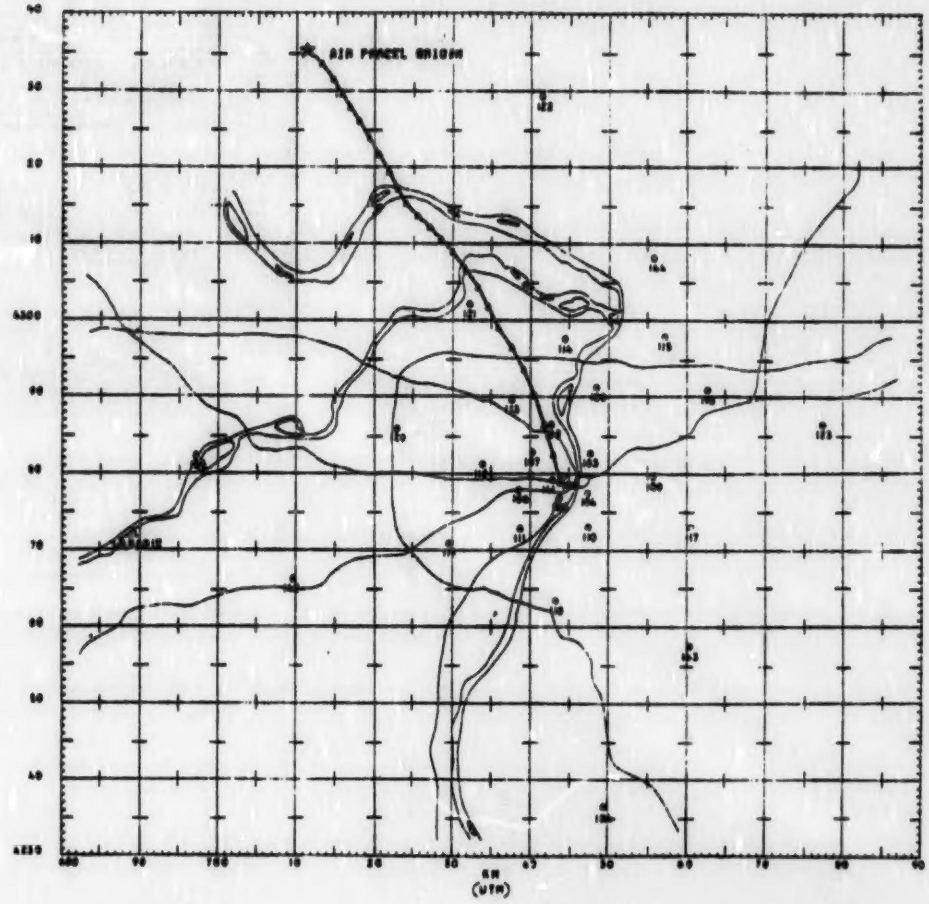
AIR PARCEL ORIGIN
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KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #42
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 900 CST 24 JUL 75
ARRIVING 1500 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 24 JUL 75    900 CST      END TIME: 24 JUL 75  1500 CST
    INITIAL COORDINATES: 4278730N. 743590E.     LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 24

                                                                                     ACCUMULATED DISPLACEMENT
                                             INCREMENTAL DISPLACEMENT              PATH      AZIMUTH          SPEED
STEP   TIME           LOCATION           RADIAL     AZIMUTH        SPEED          LENGTH  (FROM ORIGIN)  (ALONG PATH)
  0    1500 CST   4278750N.  743880E.        0 M       0 DEG       0 M/SEC          0 M       0 DEG        0 M/SEC
  1    1445 CST   4282396N.  742979E.   3756.0 M   346.1 DEG    4.17 M/SEC     3756.0 M   346.1 DEG     4.17 M/SEC
  2    1430 CST   4285739N.  741385E.   4044.0 M   344.3 DEG    4.49 M/SEC     7799.9 M   345.2 DEG     4.33 M/SEC
  3    1415 CST   4290072N.  740605E.   3993.1 M   341.3 DEG    4.44 M/SEC    11793.0 M   343.9 DEG     4.37 M/SEC
  4    1400 CST   4293393N.  739296E.   3570.3 M   338.5 DEG    3.97 M/SEC    15363.3 M   342.6 DEG     4.27 M/SEC
  5    1345 CST   4296319N.  737749E.   3309.5 M   332.1 DEG    3.68 M/SEC    18672.8 M   340.8 DEG     4.15 M/SEC
  6    1330 CST   4298923N.  735026E.   3122.8 M   326.5 DEG    3.47 M/SEC    21795.6 M   339.7 DEG     4.04 M/SEC
  7    1315 CST   4301593N.  734725E.   2970.0 M   334.0 DEG    3.30 M/SEC    24765.6 M   338.2 DEG     3.93 M/SEC
  8    1300 CST   4304151N.  733419E.   2872.1 M   332.9 DEG    3.19 M/SEC    27637.7 M   337.6 DEG     3.84 M/SEC
  9    1245 CST   4306362N.  731657E.   2873.0 M   327.1 DEG    3.19 M/SEC    30510.7 M   336.6 DEG     3.77 M/SEC
 10    1230 CST   4308741N.  730223E.   2723.3 M   323.1 DEG    3.03 M/SEC    33234.0 M   335.5 DEG     3.69 M/SEC
 11    1215 CST   4310477N.  728718E.   2297.5 M   319.1 DEG    2.55 M/SEC    35531.5 M   334.5 DEG     3.59 M/SEC
 12    1200 CST   4311957N.  727324E.   2026.0 M   316.9 DEG    2.25 M/SEC    37557.5 M   333.5 DEG     3.48 M/SEC
 13    1145 CST   4313409N.  725749E.   2150.8 M   312.5 DEG    2.39 M/SEC    39708.2 M   332.4 DEG     3.39 M/SEC
 14    1130 CST   4315047N.  724265E.   2204.5 M   317.7 DEG    2.45 M/SEC    41912.8 M   331.6 DEG     3.33 M/SEC
 15    1115 CST   4316968N.  723224E.   2190.1 M   331.6 DEG    2.43 M/SEC    44102.9 M   331.6 DEG     3.27 M/SEC
 16    1100 CST   4319126N.  722164E.   2405.0 M   333.9 DEG    2.67 M/SEC    46507.9 M   331.7 DEG     3.23 M/SEC
 17    1045 CST   4321339N.  720939E.   2528.9 M   331.0 DEG    2.81 M/SEC    49036.8 M   331.7 DEG     3.21 M/SEC
 18    1030 CST   4323606N.  719671E.   2597.8 M   330.8 DEG    2.89 M/SEC    51634.6 M   331.6 DEG     3.19 M/SEC
 19    1015 CST   4325754N.  718394E.   2499.0 M   329.3 DEG    2.79 M/SEC    54133.6 M   331.5 DEG     3.17 M/SEC
 20    1000 CST   4327569N.  717247E.   2147.0 M   327.7 DEG    2.39 M/SEC    56280.6 M   331.4 DEG     3.13 M/SEC
 21     945 CST   4329318N.  716204E.   2034.1 M   329.1 DEG    2.26 M/SEC    58314.7 M   331.3 DEG     3.09 M/SEC
 22     930 CST   4331163N.  715151E.   2126.1 M   330.3 DEG    2.36 M/SEC    60440.8 M   331.3 DEG     3.05 M/SEC
 23     915 CST   4333199N.  713655E.   2519.2 M   323.5 DEG    2.80 M/SEC    62960.0 M   331.0 DEG     3.04 M/SEC
 24     900 CST   4335008N.  711763E.   2609.5 M   314.2 DEG    2.90 M/SEC    65569.5 M   330.3 DEG     3.04 M/SEC
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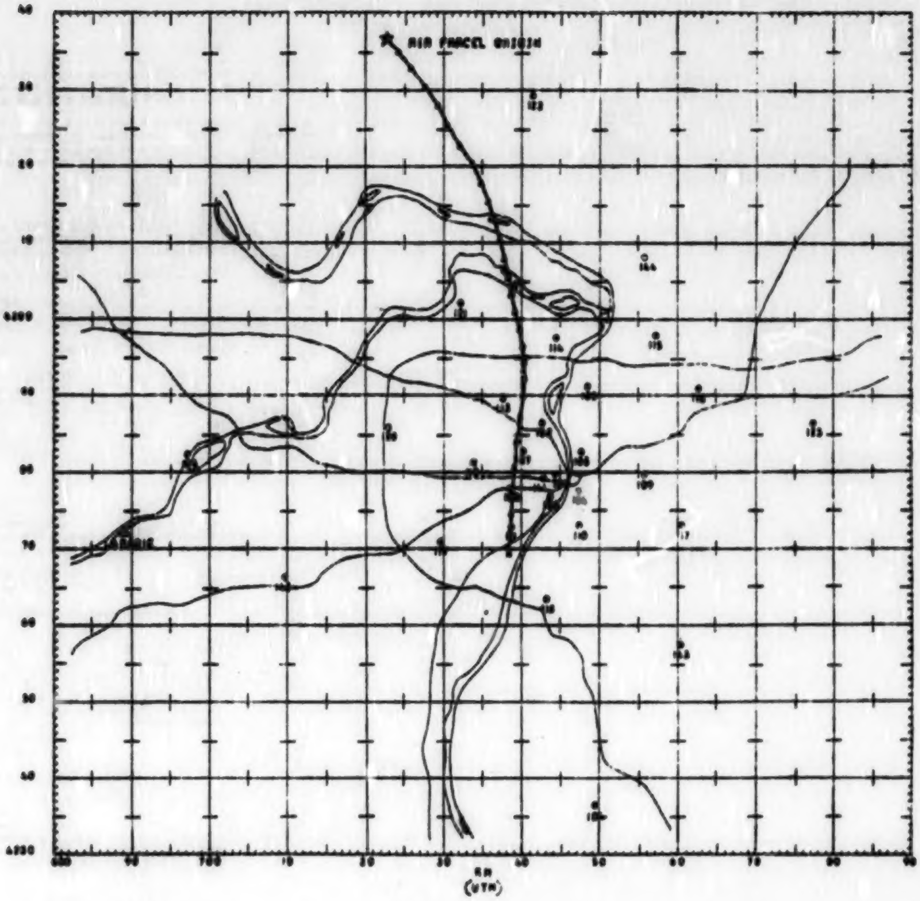
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KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #43
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1215 CST 24 JUL 75
ARRIVING 1800 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

```
RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 24 JUL 75  1215 CST      END TIME: 24 JUL 75  1900 CST
     INITIAL COORDINATES: 4269380N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HUECK
     TRAJECTORY TYPE: BACKWARD IN TIME
     STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 27

                                        INCREMENTAL DISPLACEMENT                 ACCUMULATED DISPLACEMENT
STEP   TIME          LOCATION          RADIAL   AZIMUTH      SPEED          PATH        AZIMUTH         SPEED
                                                                          LENGTH  (FROM ORIGIN) (ALONG PATH)
  0   1900 CST  4269380N. 738500E.       0 M      0 DEG      0 M/SEC          0 M      0 DEG      0 M/SEC
  1   1845 CST  4271905N. 738591E.  2526.9 M    2.1 DEG   2.81 M/SEC     2526.9 M    2.1 DEG   2.81 M/SEC
  2   1830 CST  4274503N. 738730E.  2602.0 M    3.1 DEG   2.89 M/SEC     5128.9 M    2.6 DEG   2.85 M/SEC
  3   1815 CST  4277297N. 738918E.  2800.3 M    3.8 DEG   3.11 M/SEC     7929.1 M    3.0 DEG   2.94 M/SEC
  4   1800 CST  4280464N. 739143E.  3174.7 M    4.1 DEG   3.53 M/SEC    11103.8 M    3.3 DEG   3.08 M/SEC
  5   1745 CST  4283907N. 739429E.  3455.6 M    4.8 DEG   3.84 M/SEC    14559.4 M    3.7 DEG   3.24 M/SEC
  6   1730 CST  4287188N. 739884E.  3311.6 M    7.9 DEG   3.68 M/SEC    17870.9 M    4.4 DEG   3.31 M/SEC
  7   1715 CST  4289990N. 740279E.  2731.5 M    8.3 DEG   3.04 M/SEC    20602.4 M    5.0 DEG   3.27 M/SEC
  8   1700 CST  4292120N. 740452E.  2236.5 M    4.5 DEG   2.49 M/SEC    22838.9 M    4.9 DEG   3.17 M/SEC
  9   1645 CST  4294329N. 740403E.  2209.7 M  358.7 DEG   2.46 M/SEC    25048.7 M    4.4 DEG   3.09 M/SEC
 10   1630 CST  4296452N. 740191E.  2133.1 M  354.3 DEG   2.37 M/SEC    27181.8 M    3.6 DEG   3.02 M/SEC
 11   1615 CST  4298610N. 739768E.  2199.6 M  348.9 DEG   2.44 M/SEC    29381.4 M    2.5 DEG   2.97 M/SEC
 12   1600 CST  4300891N. 739220E.  2345.5 M  346.5 DEG   2.61 M/SEC    31726.9 M    1.3 DEG   2.94 M/SEC
 13   1545 CST  430[illegible]85N. 738758E.  2242.2 M  348.1 DEG   2.49 M/SEC    33969.1 M    0.4 DEG   2.90 M/SEC
 14   1530 CST  4305339N. 738347E.  2290.9 M  349.7 DEG   2.55 M/SEC    36260.0 M  359.8 DEG   2.88 M/SEC
 15   1515 CST  4307775N. 737848E.  2497.0 M  348.4 DEG   2.76 M/SEC    38747.0 M  359.0 DEG   2.87 M/SEC
 16   1500 CST  4310326N. 737257E.  2618.3 M  346.9 DEG   2.91 M/SEC    41365.3 M  358.3 DEG   2.87 M/SEC
 17   1445 CST  4312829N. 736578E.  2593.8 M  344.8 DEG   2.88 M/SEC    43959.0 M  357.5 DEG   2.87 M/SEC
 18   1430 CST  4315163N. 735785E.  2465.4 M  341.2 DEG   2.74 M/SEC    46424.4 M  356.6 DEG   2.87 M/SEC
 19   1415 CST  4317523N. 734896E.  2520.8 M  339.4 DEG   2.80 M/SEC    48945.3 M  355.7 DEG   2.86 M/SEC
 20   1400 CST  4320043N. 733766E.  2762.0 M  335.9 DEG   3.07 M/SEC    51707.3 M  354.7 DEG   2.87 M/SEC
 21   1345 CST  4322421N. 732175E.  2861.1 M  326.2 DEG   3.18 M/SEC    54568.3 M  353.2 DEG   2.89 M/SEC
 22   1330 CST  4324919N. 730639E.  2932.5 M  328.4 DEG   3.26 M/SEC    57500.9 M  351.9 DEG   2.90 M/SEC
 23   1315 CST  4327609N. 729380E.  2970.6 M  334.9 DEG   3.30 M/SEC    60471.4 M  351.1 DEG   2.92 M/SEC
 24   1300 CST  4330072N. 727724E.  2968.0 M  326.1 DEG   3.30 M/SEC    63439.5 M  349.9 DEG   2.94 M/SEC
 25   1245 CST  4332400N. 725551E.  2925.9 M  322.7 DEG   3.25 M/SEC    66365.3 M  348.7 DEG   2.95 M/SEC
 26   1230 CST  4334556N. 724297E.  2725.5 M  322.6 DEG   3.03 M/SEC    69090.9 M  347.7 DEG   2.95 M/SEC
 27   1215 CST  4336211N. 722749E.  2335.2 M  318.3 DEG   2.59 M/SEC    71425.9 M  346.8 DEG   2.94 M/SEC
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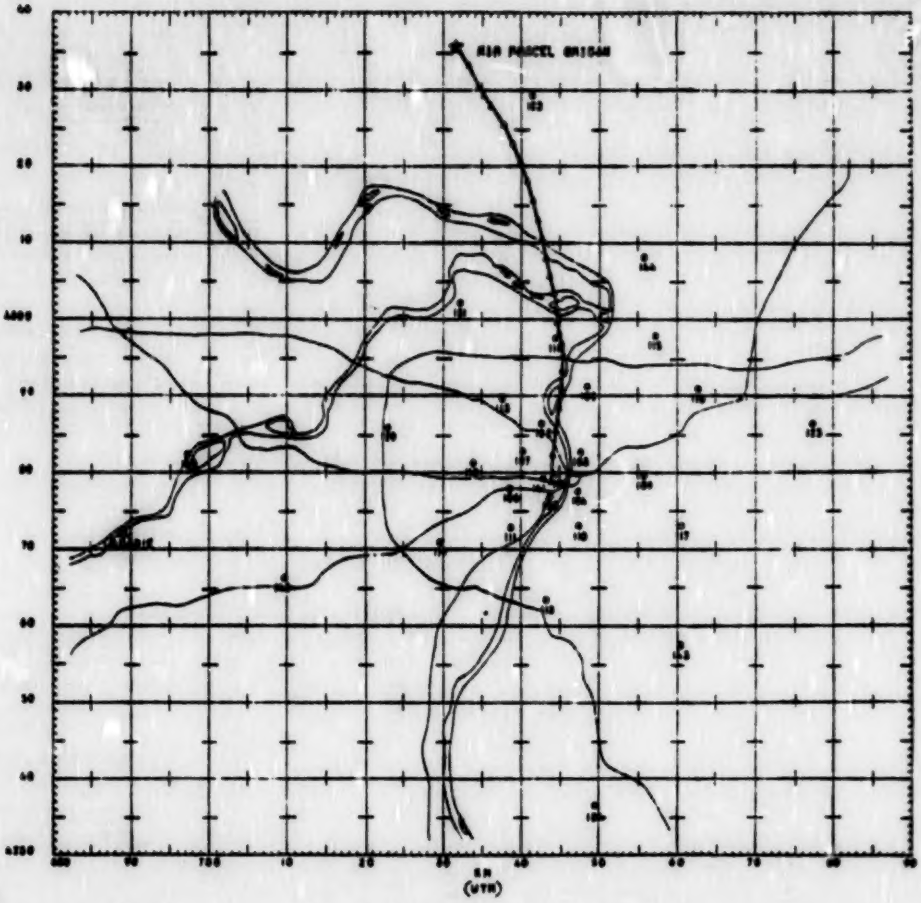
AIR PARCEL ORIGIN
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KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #44
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1300 CST 24 JUL 75
ARRIVING 1900 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 24 JUL 75  1300 CST      END TIME: 24 JUL 75  1900 CST
    INITIAL COORDINATES: 4278750N. 743880E.      LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 24

                                                                                  ACCUMULATED DISPLACEMENT
                                          INCREMENTAL DISPLACEMENT
                                                                              PATH        AZIMUTH          SPEED
STEP   TIME        LOCATION             RADIAL     AZIMUTH       SPEED          LENGTH   (FROM ORIGIN)  (ALONG PATH)

  0   1900 CST  4278750N.  743880E.         0 M       0 DEG       0 M/SEC          0 M       0 DEG       0 M/SEC
  1   1845 CST  4282188N.  744100E.    3446.2 M     3.9 DEG    3.83 M/SEC     3446.2 M     3.8 DEG    3.83 M/SEC
  2   1830 CST  4285411N.  744480E.    3244.4 M     6.6 DEG    3.60 M/SEC     6690.6 M     5.1 DEG    3.72 M/SEC
  3   1815 CST  4288345N.  744916E.    2966.1 M     6.5 DEG    3.30 M/SEC     9656.6 M     6.2 DEG    3.58 M/SEC
  4   1800 CST  4290987N.  745148E.    2651.7 M     5.0 DEG    2.95 M/SEC    12308.4 M     5.9 DEG    3.42 M/SEC
  5   1745 CST  4293170N.  745270E.    2186.9 M     3.2 DEG    2.43 M/SEC    14495.3 M     5.5 DEG    3.22 M/SEC
  6   1730 CST  4295025N.  745392E.    1858.5 M     3.8 DEG    2.06 M/SEC    16353.8 M     5.3 DEG    3.03 M/SEC
  7   1715 CST  4296591N.  745277E.    1660.9 M   356.0 DEG    1.85 M/SEC    18014.7 M     4.5 DEG    2.86 M/SEC
  8   1700 CST  4298772N.  744932E.    1432.9 M   346.1 DEG    1.59 M/SEC    19447.6 M     3.1 DEG    2.70 M/SEC
  9   1645 CST  4299516N.  744662E.    1469.2 M   349.4 DEG    1.63 M/SEC    20916.8 M     2.2 DEG    2.58 M/SEC
 10   1630 CST  4301233N.  744541E.    1726.3 M   356.0 DEG    1.92 M/SEC    22643.2 M     1.7 DEG    2.52 M/SEC
 11   1615 CST  4303286N.  744251E.    2067.6 M   351.9 DEG    2.30 M/SEC    24710.8 M     0.9 DEG    2.50 M/SEC
 12   1600 CST  4305544N.  743723E.    2319.8 M   346.8 DEG    2.58 M/SEC    27029.6 M   359.7 DEG    2.50 M/SEC
 13   1545 CST  4307833N.  743228E.    2342.7 M   347.9 DEG    2.60 M/SEC    29372.3 M   358.7 DEG    2.51 M/SEC
 14   1530 CST  4310218N.  742779E.    2425.1 M   349.3 DEG    2.70 M/SEC    31793.4 M   358.0 DEG    2.52 M/SEC
 15   1515 CST  4312750N.  742230E.    2559.2 M   347.8 DEG    2.88 M/SEC    34359.5 M   357.2 DEG    2.55 M/SEC
 16   1500 CST  4315243N.  741578E.    2674.0 M   345.7 DEG    2.97 M/SEC    37063.5 M   356.4 DEG    2.57 M/SEC
 17   1445 CST  4317877N.  740846E.    2637.9 M   343.9 DEG    2.93 M/SEC    39701.5 M   355.6 DEG    2.59 M/SEC
 18   1430 CST  4320246N.  740005E.    2513.1 M   340.5 DEG    2.79 M/SEC    42214.6 M   354.7 DEG    2.61 M/SEC
 19   1415 CST  4322629N.  739051E.    2567.2 M   338.2 DEG    2.85 M/SEC    44781.8 M   353.7 DEG    2.62 M/SEC
 20   1400 CST  4325169N.  737865E.    2802.7 M   335.0 DEG    3.11 M/SEC    47584.5 M   352.6 DEG    2.64 M/SEC
 21   1345 CST  4327574N.  736246E.    2899.7 M   326.0 DEG    3.22 M/SEC    50484.2 M   351.1 DEG    2.67 M/SEC
 22   1330 CST  4330100N.  734682E.    2973.6 M   328.3 DEG    3.30 M/SEC    53457.8 M   349.8 DEG    2.70 M/SEC
 23   1315 CST  4332802N.  733392E.    2994.9 M   334.5 DEG    3.33 M/SEC    56449.6 M   349.0 DEG    2.73 M/SEC
 24   1300 CST  4335258N.  731707E.    2978.4 M   325.6 DEG    3.31 M/SEC    59428.0 M   347.8 DEG    2.75 M/SEC
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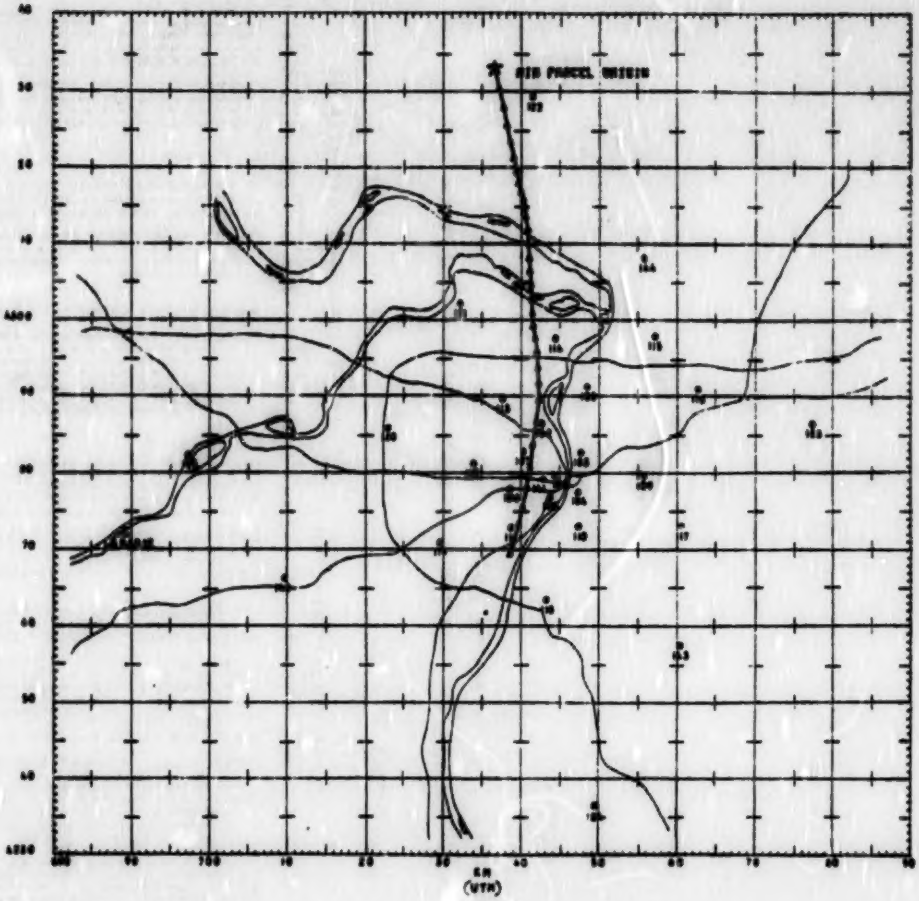

AIR PARCEL ORIGIN
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KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #45
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
BROADWAY AND HURCK

STARTING 1500 CST 24 JUL 75
ARRIVING 2300 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 24 JUL 75  1500 CST      END TIME: 24 JUL 75  2300 CST
    INITIAL COORDINATES: 4269380N. 738500E.      LOCATION DESCRIPTOR: BROADWAY AND HURCK
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 32

                                                                                ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT
                                                                              PATH      AZIMUTH        SPEED
STEP   TIME          LOCATION            RADIAL    AZIMUTH      SPEED       LENGTH  (FROM ORIGIN) (ALONG PATH)

  0   2300 CST  4269380N. 738500E.        0 M       0 DEG      0 M/SEC          0 M      0 DEG      0 M/SEC
  1   2245 CST  4271305N. 739056E.   2003.9 M    16.1 DEG   2.23 M/SEC     2003.8 M   16.1 DEG   2.23 M/SEC
  2   2230 CST  4273381N. 739633E.   2117.0 M    15.8 DEG   2.35 M/SEC     4120.8 M   16.0 DEG   2.29 M/SEC
  3   2215 CST  4275551N. 740137E.   2266.0 M    12.8 DEG   2.52 M/SEC     6386.8 M   14.9 DEG   2.37 M/SEC
  4   2200 CST  4278012N. 740660E.   2516.9 M    12.0 DEG   2.80 M/SEC     8903.7 M   14.1 DEG   2.47 M/SEC
  5   2145 CST  4280719N. 741122E.   2746.0 M     9.7 DEG   3.05 M/SEC    11649.7 M   13.0 DEG   2.59 M/SEC
  6   2130 CST  4283647N. 741424E.   2943.4 M     5.9 DEG   3.27 M/SEC    14593.1 M   11.6 DEG   2.70 M/SEC
  7   2115 CST  4286665N. 741908E.   3055.2 M     9.1 DEG   3.40 M/SEC    17649.3 M   11.2 DEG   2.80 M/SEC
  8   2100 CST  4289386N. 742260E.   2743.4 M     7.4 DEG   3.05 M/SEC    20392.7 M   10.6 DEG   2.83 M/SEC
  9   2045 CST  4291619N. 742231E.   2233.2 M   359.3 DEG   2.48 M/SEC    22625.9 M    9.5 DEG   2.79 M/SEC
 10   2030 CST  4293693N. 742141E.   2076.3 M   357.5 DEG   2.31 M/SEC    24702.2 M    8.5 DEG   2.74 M/SEC
 11   2015 CST  4295763N. 742036E.   2073.1 M   357.1 DEG   2.30 M/SEC    26775.3 M    7.6 DEG   2.70 M/SEC
 12   2000 CST  4297546N. 741817E.   1795.3 M   353.1 DEG   1.99 M/SEC    28570.5 M    6.7 DEG   2.65 M/SEC
 13   1945 CST  4299160N. 741544E.   1637.4 M   350.3 DEG   1.82 M/SEC    30208.0 M    5.8 DEG   2.58 M/SEC
 14   1930 CST  4300783N. 741397E.   1630.1 M   354.8 DEG   1.81 M/SEC    31838.1 M    5.3 DEG   2.53 M/SEC
 15   1915 CST  4302550N. 741347E.   1767.1 M   358.4 DEG   1.96 M/SEC    33605.2 M    4.9 DEG   2.49 M/SEC
 16   1900 CST  4304477N. 741268E.   1928.6 M   357.7 DEG   2.14 M/SEC    35533.8 M    4.5 DEG   2.47 M/SEC
 17   1845 CST  4306246N. 741146E.   1773.2 M   356.1 DEG   1.97 M/SEC    37307.0 M    4.1 DEG   2.44 M/SEC
 18   1830 CST  4307974N. 741050E.   1731.0 M   356.9 DEG   1.92 M/SEC    39038.0 M    3.8 DEG   2.41 M/SEC
 19   1815 CST  4309790N. 740947E.   1817.5 M   358.0 DEG   2.02 M/SEC    40855.5 M    3.5 DEG   2.39 M/SEC
 20   1800 CST  4311646N. 740872E.   1858.5 M   357.1 DEG   2.07 M/SEC    42714.0 M    3.2 DEG   2.37 M/SEC
 21   1745 CST  4313320N. 740471E.   1688.6 M   352.5 DEG   1.88 M/SEC    44402.6 M    2.8 DEG   2.35 M/SEC
 22   1730 CST  4314579N. 740458E.   1274.5 M   350.8 DEG   1.42 M/SEC    45677.1 M    2.5 DEG   2.31 M/SEC
 23   1715 CST  4315595N. 740224E.   1016.7 M   351.9 DEG   1.13 M/SEC    46693.9 M    2.3 DEG   2.26 M/SEC
 24   1700 CST  4316602N. 740076E.   1046.8 M   346.3 DEG   1.16 M/SEC    47740.7 M    1.9 DEG   2.21 M/SEC
 25   1645 CST  4317793N. 739759E.   1229.5 M   345.0 DEG   1.36 M/SEC    48969.1 M    1.5 DEG   2.18 M/SEC
 26   1630 CST  4319270N. 739563E.   1503.3 M   330.2 DEG   1.67 M/SEC    50472.4 M    1.2 DEG   2.16 M/SEC
 27   1615 CST  4321103N. 739179E.   1861.1 M   350.0 DEG   2.07 M/SEC    52333.5 M    0.8 DEG   2.15 M/SEC
 28   1600 CST  4323165N. 738718E.   2113.0 M   347.4 DEG   2.35 M/SEC    54446.5 M    0.2 DEG   2.16 M/SEC
 29   1545 CST  4325316N. 738275E.   2195.9 M   348.4 DEG   2.44 M/SEC    56642.3 M  359.8 DEG   2.17 M/SEC
 30   1530 CST  4327606N. 737854E.   2328.6 M   349.6 DEG   2.59 M/SEC    58970.9 M  359.4 DEG   2.18 M/SEC
 31   1515 CST  4330096N. 737323E.   2546.3 M   348.0 DEG   2.83 M/SEC    61517.2 M  358.9 DEG   2.20 M/SEC
 32   1500 CST  4332690N. 736683E.   2662.3 M   346.1 DEG   2.96 M/SEC    64179.5 M  358.4 DEG   2.23 M/SEC
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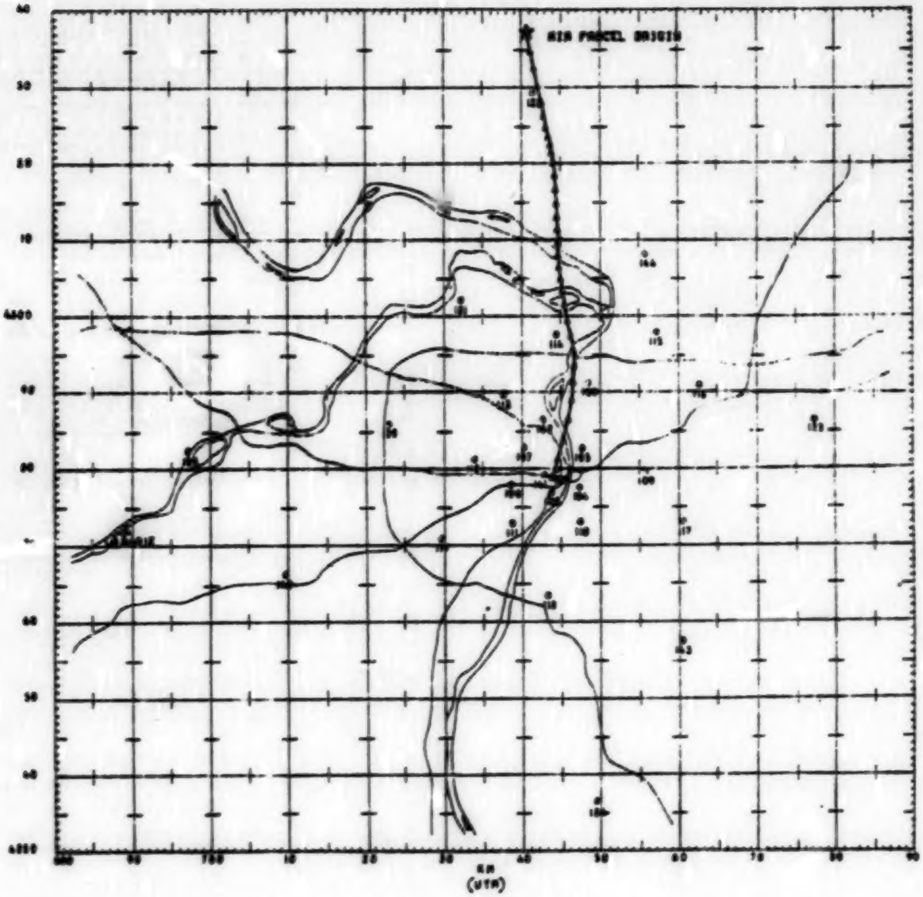
AIR PARCEL ORIGIN
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KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #46
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
14TH AND MARKET

STARTING 1515 CST 24 JUL 75
ARRIVING 2300 CST 24 JUL 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
BACKWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 24 JUL 75  1515 CST     END TIME: 24 JUL 75  2300 CST
    INITIAL COORDINATES: 4278750N. 743880E.     LOCATION DESCRIPTOR: 14TH AND MARKET
    TRAJECTORY TYPE: BACKWARD IN TIME
    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 31

                                                                                   ACCUMULATED DISPLACEMENT
                                              INCREMENTAL DISPLACEMENT          PATH       AZIMUTH        SPEED
STEP   TIME          LOCATION            RADIAL     AZIMUTH      SPEED        LENGTH  (FROM ORIGIN)  (ALONG PATH)

  0    2300 CST   4278750N. 743880E.       0 M       0 DEG      0 M/SEC         0 M       0 DEG       0 M/SEC
  1    2245 CST   4281181N. 744633E.  2545.3 M    17.2 DEG   2.83 M/SEC    2545.3 M    17.2 DEG    2.83 M/SEC
  2    2230 CST   4283817N. 745332E.  2729.8 M    14.8 DEG   3.03 M/SEC    5275.1 M    16.0 DEG    2.93 M/SEC
  3    2215 CST   4286414N. 745965E.  2672.4 M    13.7 DEG   2.97 M/SEC    7947.5 M    15.2 DEG    2.94 M/SEC
  4    2200 CST   4288915N. 746426E.  2541.8 M    10.5 DEG   2.82 M/SEC   10489.3 M    14.1 DEG    2.91 M/SEC
  5    2145 CST   4291227N. 746607E.  2319.0 M     4.5 DEG   2.58 M/SEC   12808.3 M    12.3 DEG    2.85 M/SEC
  6    2130 CST   4293352N. 746739E.  2128.5 M     3.6 DEG   2.37 M/SEC   14936.8 M    11.1 DEG    2.77 M/SEC
  7    2115 CST   4295294N. 746720E.  1942.2 M   359.4 DEG   2.16 M/SEC   16879.0 M     9.7 DEG    2.68 M/SEC
  8    2100 CST   4297229N. 746348E.  1970.5 M   349.1 DEG   2.19 M/SEC   18849.5 M     7.6 DEG    2.62 M/SEC
  9    2045 CST   4299251N. 745903E.  2070.4 M   347.6 DEG   2.30 M/SEC   20920.0 M     5.6 DEG    2.58 M/SEC
 10    2030 CST   4301281N. 745578E.  2055.9 M   350.9 DEG   2.28 M/SEC   22975.9 M     4.3 DEG    2.55 M/SEC
 11    2015 CST   4303116N. 745305E.  1855.0 M   351.5 DEG   2.06 M/SEC   24830.9 M     3.3 DEG    2.51 M/SEC
 12    2000 CST   4304674N. 745069E.  1575.6 M   351.4 DEG   1.75 M/SEC   26406.5 M     2.6 DEG    2.45 M/SEC
 13    1945 CST   4306226N. 744844E.  1568.5 M   351.8 DEG   1.74 M/SEC   27975.0 M     2.0 DEG    2.39 M/SEC
 14    1930 CST   4307740N. 744709E.  1519.9 M   354.9 DEG   1.69 M/SEC   29494.9 M     1.6 DEG    2.34 M/SEC
 15    1915 CST   4309434N. 744664E.  1694.9 M   358.5 DEG   1.88 M/SEC   31189.8 M     1.5 DEG    2.31 M/SEC
 16    1900 CST   4311169N. 744638E.  1735.1 M   359.1 DEG   1.93 M/SEC   32924.9 M     1.3 DEG    2.29 M/SEC
 17    1845 CST   4312778N. 744570E.  1610.4 M   357.6 DEG   1.79 M/SEC   34535.3 M     1.2 DEG    2.26 M/SEC
 18    1830 CST   4314517N. 744469E.  1741.5 M   356.7 DEG   1.94 M/SEC   36276.8 M     0.9 DEG    2.24 M/SEC
 19    1815 CST   4316347N. 744401E.  1831.0 M   357.9 DEG   2.03 M/SEC   38107.8 M     0.8 DEG    2.23 M/SEC
 20    1800 CST   4318206N. 744304E.  1862.2 M   357.0 DEG   2.07 M/SEC   39970.0 M     0.5 DEG    2.22 M/SEC
 21    1745 CST   4319875N. 744083E.  1683.2 M   352.5 DEG   1.87 M/SEC   41653.2 M     0.3 DEG    2.20 M/SEC
 22    1730 CST   4321143N. 743878E.  1283.9 M   350.8 DEG   1.43 M/SEC   42937.2 M   360.0 DEG    2.17 M/SEC
 23    1715 CST   4322177N. 743727E.  1045.4 M   351.7 DEG   1.16 M/SEC   43982.6 M   359.8 DEG    2.12 M/SEC
 24    1700 CST   4323217N. 743470E.  1071.6 M   346.1 DEG   1.19 M/SEC   45054.2 M   359.5 DEG    2.09 M/SEC
 25    1645 CST   4324419N. 743151E.  1244.1 M   345.1 DEG   1.38 M/SEC   46298.3 M   359.1 DEG    2.06 M/SEC
 26    1630 CST   4325917N. 742895E.  1519.5 M   350.3 DEG   1.69 M/SEC   47817.8 M   358.8 DEG    2.04 M/SEC
 27    1615 CST   4327771N. 742567E.  1882.3 M   349.9 DEG   2.09 M/SEC   49700.1 M   358.5 DEG    2.05 M/SEC
 28    1600 CST   4329857N. 742097E.  2138.7 M   347.3 DEG   2.38 M/SEC   51838.8 M   358.0 DEG    2.06 M/SEC
 29    1545 CST   4332034N. 741645E.  2222.7 M   348.3 DEG   2.47 M/SEC   54061.5 M   357.6 DEG    2.07 M/SEC
 30    1530 CST   4334348N. 741216E.  2355.4 M   349.5 DEG   2.62 M/SEC   56416.9 M   357.3 DEG    2.09 M/SEC
 31    1515 CST   4336857N. 740677E.  2564.6 M   347.9 DEG   2.85 M/SEC   58981.5 M   356.8 DEG    2.11 M/SEC
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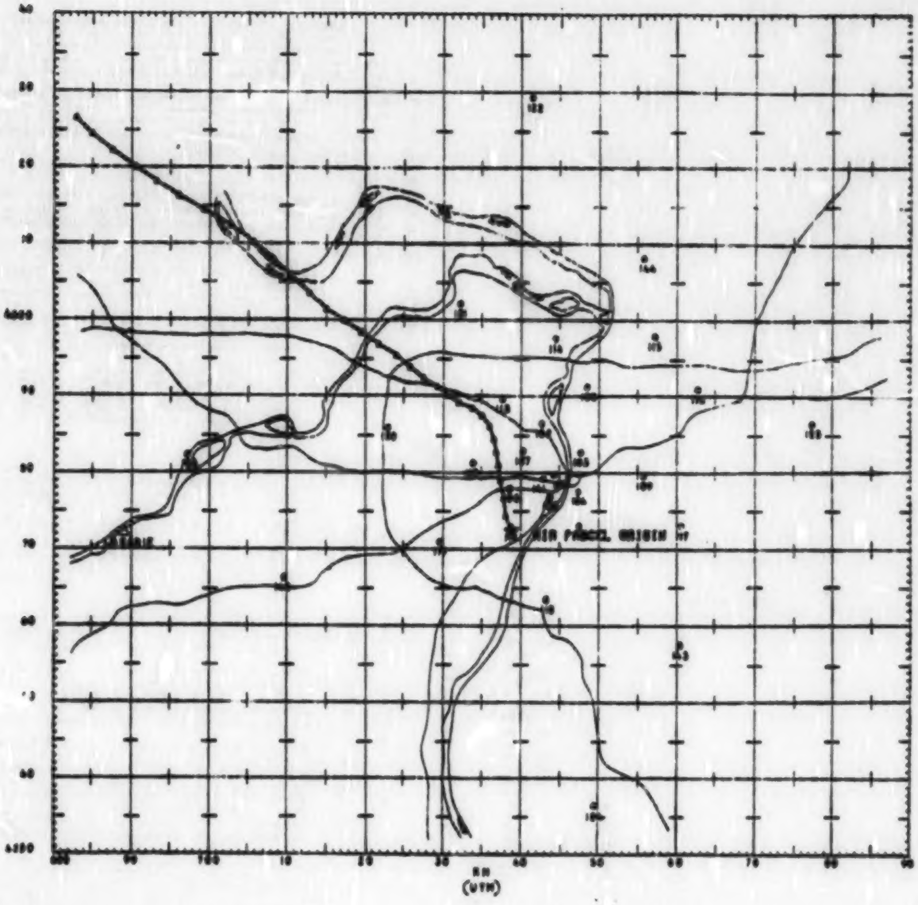
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AIR PARCEL ORIGIN
KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #47
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 111

STARTING 1000 CST 8 AUG 75
ARRIVING 1745 CST 8 AUG 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-500 SEC
SMOOTHING METHOD- INVERSE
FOREWARD TRAJECTORY

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RAMS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME:  8 AUG 75  1000 CST      END TIME:  8 AUG 75  1745 CST
    INITIAL COORDINATES: 4272479N. 738812E.      LOCATION DESCRIPTOR: RAMS STATION NO. 111
    TRAJECTORY TYPE: FORWARD IN TIME
    STEP INTERVAL:  15 MIN           NUMBER OF STEPS: 31

                                                                                        ACCUMULATED DISPLACEMENT
                                                 INCREMENTAL DISPLACEMENT        PATH       AZIMUTH          SPEED
STEP    TIME          LOCATION              RADIAL     AZIMUTH        SPEED      LENGTH  (FROM ORIGIN)   (ALONG PATH)

  0    1000 CST   4272479N.  738812E.         0 M       0 DEG      0  M/SEC          0 M      0 DEG       0  M/SEC
  1    1015 CST   4274445N.  738147E.    2075.5 M   161.3 DEG   2.31  M/SEC     2075.5 M  161.3 DEG    2.31  M/SEC
  2    1030 CST   4276636N.  737849E.    2211.2 M   172.3 DEG   2.46  M/SEC     4280.7 M  167.0 DEG    2.38  M/SEC
  3    1045 CST   4278599N.  737493E.    2395.5 M   171.4 DEG   2.66  M/SEC     6676.3 M  168.6 DEG    2.47  M/SEC
  4    1100 CST   4281029N.  737221E.    2048.3 M   173.4 DEG   2.28  M/SEC     8724.6 M  169.5 DEG    2.42  M/SEC
  5    1115 CST   4282711N.  736948E.    1703.8 M   170.8 DEG   1.89  M/SEC    10428.4 M  169.7 DEG    2.32  M/SEC
  6    1130 CST   4284401N.  736631E.    1720.3 M   165.4 DEG   1.91  M/SEC    12148.7 M  169.6 DEG    2.25  M/SEC
  7    1145 CST   4286090N.  736126E.    1762.3 M   162.3 DEG   1.96  M/SEC    13910.9 M  168.8 DEG    2.21  M/SEC
  8    1200 CST   4287465N.  735157E.    1682.7 M   144.9 DEG   1.87  M/SEC    15593.6 M  166.3 DEG    2.17  M/SEC
  9    1215 CST   4288455N.  733915E.    1587.3 M   128.5 DEG   1.76  M/SEC    17180.9 M  163.0 DEG    2.12  M/SEC
 10    1230 CST   4289183N.  732210E.    1854.0 M   113.1 DEG   2.06  M/SEC    19035.0 M  158.4 DEG    2.11  M/SEC
 11    1245 CST   4290122N.  730734E.    1750.0 M   123.5 DEG   1.94  M/SEC    20785.0 M  155.4 DEG    2.10  M/SEC
 12    1300 CST   4291240N.  729474E.    1684.2 M   131.6 DEG   1.87  M/SEC    22469.2 M  153.3 DEG    2.08  M/SEC
 13    1315 CST   4292397N.  727744E.    2081.0 M   123.8 DEG   2.31  M/SEC    24550.3 M  150.9 DEG    2.10  M/SEC
 14    1330 CST   4293752N.  725992E.    2221.5 M   127.9 DEG   2.47  M/SEC    26771.7 M  148.9 DEG    2.12  M/SEC
 15    1345 CST   4295368N.  724229E.    2384.3 M   132.3 DEG   2.65  M/SEC    29156.0 M  147.5 DEG    2.16  M/SEC
 16    1400 CST   4296755N.  721997E.    2628.1 M   121.8 DEG   2.92  M/SEC    31784.1 M  145.3 DEG    2.21  M/SEC
 17    1415 CST   4298354N.  719703E.    2796.3 M   124.9 DEG   3.11  M/SEC    34580.4 M  143.6 DEG    2.26  M/SEC
 18    1430 CST   4299908N.  717625E.    2673.5 M   125.5 DEG   2.97  M/SEC    37253.9 M  142.2 DEG    2.30  M/SEC
 19    1445 CST   4301381N.  715324E.    2648.7 M   123.8 DEG   2.94  M/SEC    39902.6 M  140.9 DEG    2.33  M/SEC
 20    1500 CST   4303363N.  713198E.    2905.7 M   133.0 DEG   3.23  M/SEC    42808.3 M  140.3 DEG    2.38  M/SEC
 21    1515 CST   4305487N.  710974E.    3076.1 M   133.7 DEG   3.42  M/SEC    45884.4 M  139.9 DEG    2.43  M/SEC
 22    1530 CST   4307837N.  708638E.    3313.4 M   135.2 DEG   3.68  M/SEC    49197.7 M  139.5 DEG    2.48  M/SEC
 23    1545 CST   4310110N.  706115E.    3396.3 M   132.0 DEG   3.77  M/SEC    52596.0 M  139.0 DEG    2.54  M/SEC
 24    1600 CST   4312225N.  703124E.    3663.0 M   128.3 DEG   4.07  M/SEC    56259.0 M  138.1 DEG    2.60  M/SEC
 25    1615 CST   4314256N.  699686E.    3993.2 M   120.6 DEG   4.44  M/SEC    60252.3 M  136.9 DEG    2.68  M/SEC
 26    1630 CST   4316136N.  696494E.    3704.5 M   120.5 DEG   4.12  M/SEC    63956.8 M  135.9 DEG    2.73  M/SEC
 27    1645 CST   4317992N.  693692E.    3360.3 M   123.5 DEG   3.73  M/SEC    67317.1 M  135.2 DEG    2.77  M/SEC
 28    1700 CST   4319909N.  690965E.    3334.3 M   125.1 DEG   3.70  M/SEC    70651.3 M  134.7 DEG    2.80  M/SEC
 29    1715 CST   4322007N.  688075E.    3570.6 M   126.0 DEG   3.97  M/SEC    74221.9 M  134.3 DEG    2.84  M/SEC
 30    1730 CST   4324189N.  685463E.    3403.3 M   126.9 DEG   3.78  M/SEC    77625.1 M  134.1 DEG    2.88  M/SEC
 31    1745 CST   4326305N.  683460E.    2914.7 M   136.6 DEG   3.24  M/SEC    80539.8 M  134.2 DEG    2.89  M/SEC
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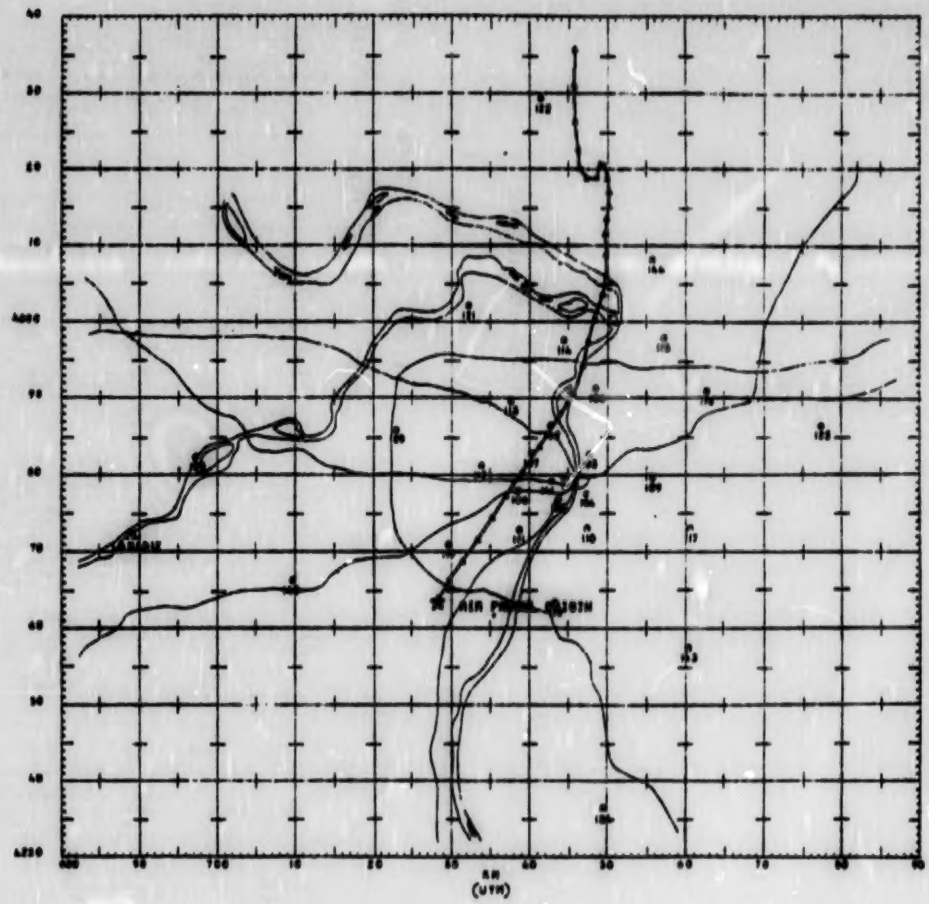
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KM
(UTM)

RAMS NEAR-SFC TRAJECTORY #48

ST. LOUIS, MO.

LOCATION DESCRIPTOR:
KETC-TV TOWER (1000')

STARTING 1000 CST 11 AUG 75
ARRIVING 1715 CST 11 AUG 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
FOREWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

    START TIME: 11 AUG 75  1000 CST      END TIME: 11 AUG 75  1715 CST

    INITIAL COORDINATES: 4263440N. 728295E.      LOCATION DESCRIPTOR: KETC-TV TOWER(1000')

    TRAJECTORY TYPE: BACKWARD IN TIME

    STEP INTERVAL:  15 MIN          NUMBER OF STEPS: 29

                                                                                   ACCUMULATED DISPLACEMENT
                                                  INCREMENTAL DISPLACEMENT
                                                                             PATH        AZIMUTH         SPEED
STEP   TIME          LOCATION            RADIAL    AZIMUTH       SPEED       LENGTH  (FROM ORIGIN) (ALONG PATH)

  0    1000 CST  4263440N.  728295E.        0 M       0 DEG     0 M/SEC          0 M      0 DEG        0 M/SEC
  1    1015 CST  4266208N.  729796E.   3149.8 M   208.5 DEG  3.50 M/SEC     3149.8 M  208.5 DEG     3.50 M/SEC
  2    1030 CST  4268725N.  731522E.   3052.0 M   214.4 DEG  3.39 M/SEC     6201.7 M  211.4 DEG     3.45 M/SEC
  3    1045 CST  4271536N.  733459E.   3413.3 M   214.6 DEG  3.79 M/SEC     9615.0 M  212.5 DEG     3.56 M/SEC
  4    1100 CST  4274393N.  735347E.   3424.4 M   213.5 DEG  3.80 M/SEC    13039.4 M  212.8 DEG     3.62 M/SEC
  5    1115 CST  4277231N.  737067E.   3318.4 M   211.2 DEG  3.69 M/SEC    16357.8 M  212.5 DEG     3.64 M/SEC
  6    1130 CST  4280256N.  739129E.   3660.7 M   214.3 DEG  4.07 M/SEC    20018.6 M  212.8 DEG     3.71 M/SEC
  7    1145 CST  4283597N.  741324E.   3989.6 M   213.4 DEG  4.43 M/SEC    24008.2 M  212.9 DEG     3.81 M/SEC
  8    1200 CST  4287112N.  743621E.   4207.7 M   213.1 DEG  4.68 M/SEC    28215.9 M  212.9 DEG     3.92 M/SEC
  9    1215 CST  4290607N.  745677E.   4054.7 M   210.5 DEG  4.51 M/SEC    32270.6 M  212.6 DEG     3.98 M/SEC
 10    1230 CST  4294157N.  746858E.   3741.2 M   198.4 DEG  4.16 M/SEC    36011.9 M  211.1 DEG     4.00 M/SEC
 11    1245 CST  4297350N.  747505E.   3258.0 M   191.4 DEG  3.62 M/SEC    39269.9 M  209.5 DEG     3.97 M/SEC
 12    1300 CST  4300390N.  748350E.   3155.5 M   195.5 DEG  3.51 M/SEC    42425.4 M  208.5 DEG     3.93 M/SEC
 13    1315 CST  4303457N.  749383E.   3236.1 M   198.6 DEG  3.60 M/SEC    45661.4 M  207.8 DEG     3.90 M/SEC
 14    1330 CST  4306026N.  749765E.   2597.1 M   188.5 DEG  2.89 M/SEC    48258.5 M  206.8 DEG     3.83 M/SEC
 15    1345 CST  4308618N.  749761E.   2591.6 M   179.9 DEG  2.88 M/SEC    50850.1 M  205.4 DEG     3.77 M/SEC
 16    1400 CST  4311290N.  749684E.   2673.3 M   178.3 DEG  2.97 M/SEC    53523.4 M  204.1 DEG     3.72 M/SEC
 17    1415 CST  4313281N.  749867E.   1999.4 M   185.3 DEG  2.22 M/SEC    55522.8 M  203.4 DEG     3.63 M/SEC
 18    1430 CST  4314981N.  750153E.   1723.8 M   189.6 DEG  1.92 M/SEC    57246.6 M  203.0 DEG     3.53 M/SEC
 19    1445 CST  4316807N.  750218E.   1827.4 M   192.0 DEG  2.03 M/SEC    59074.0 M  202.3 DEG     3.45 M/SEC
 20    1500 CST  4318618N.  750010E.   1823.2 M   173.5 DEG  2.03 M/SEC    60897.2 M  201.5 DEG     3.38 M/SEC
 21    1515 CST  4320290N.  749534E.   1738.4 M   164.1 DEG  1.93 M/SEC    62635.6 M  200.5 DEG     3.31 M/SEC
 22    1530 CST  4320437N.  749084E.    473.7 M   108.1 DEG  0.53 M/SEC    63109.2 M  200.0 DEG     3.19 M/SEC
 23    1545 CST  4318694N.  748623E.   1803.7 M    14.8 DEG  2.00 M/SEC    64913.0 M  200.2 DEG     3.14 M/SEC
 24    1600 CST  4318606N.  747379E.   1247.1 M    86.0 DEG  1.39 M/SEC    66160.1 M  199.1 DEG     3.06 M/SEC
 25    1615 CST  4319877N.  746484E.   1555.0 M   144.8 DEG  1.73 M/SEC    67715.0 M  197.9 DEG     3.01 M/SEC
 26    1630 CST  4322341N.  746263E.   2473.4 M   174.9 DEG  2.75 M/SEC    70188.4 M  197.0 DEG     3.00 M/SEC
 27    1645 CST  4326055N.  745908E.   3731.1 M   174.5 DEG  4.15 M/SEC    73919.5 M  195.7 DEG     3.04 M/SEC
 28    1700 CST  4330640N.  745806E.   4585.5 M   178.7 DEG  5.10 M/SEC    78505.0 M  194.6 DEG     3.12 M/SEC
 29    1715 CST  4335437N.  745876E.   4797.9 M   180.8 DEG  5.33 M/SEC    83302.9 M  193.7 DEG     3.19 M/SEC
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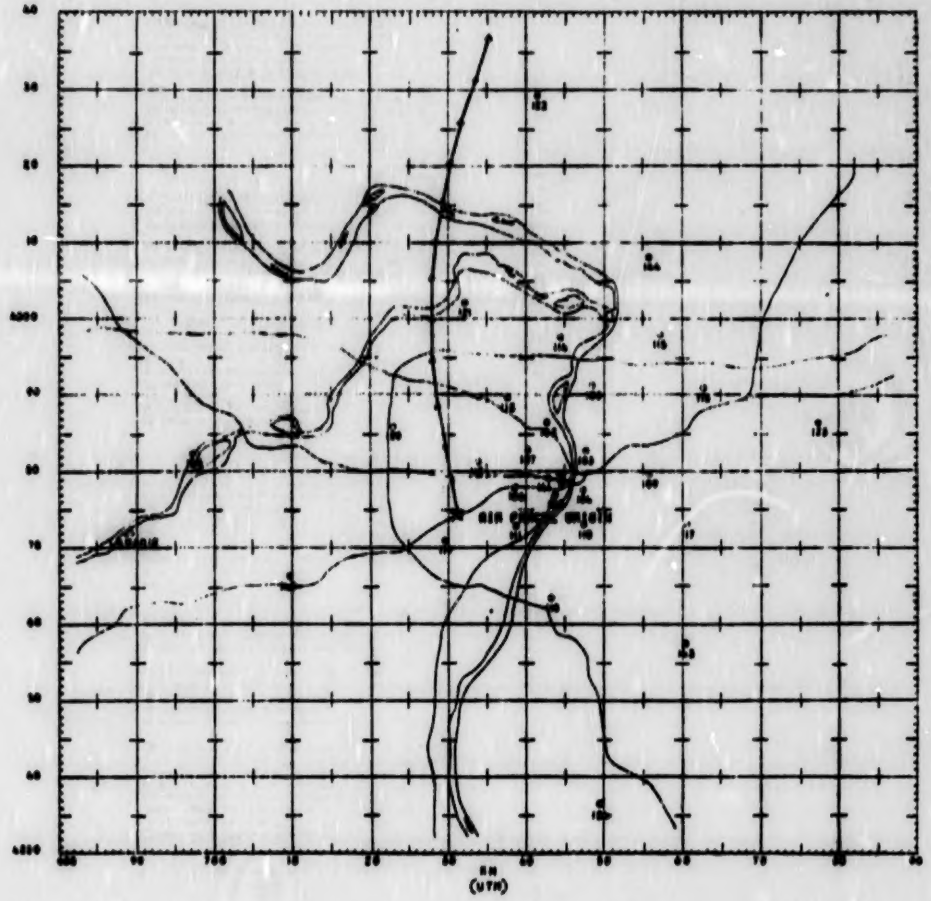
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700
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80
90
KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #49
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
WEBSTER COLLEGE (20')

STARTING 2000 CST 12 AUG 75
ARRIVING 2345 CST 12 AUG 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
FOREWARD TRAJECTORY

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RAPS NEAR-SURFACE AIR PARCEL TRAJECTORY

     START TIME: 12 AUG 75   2000 CST      END TIME: 12 AUG 75   2300 CST
     INITIAL COORDINATES: 4274510N. 731225E.      LOCATION DESCRIPTION: WEBSTER COLLEGE(20')
     TRAJECTORY TYPE: FORWARD IN TIME
     STEP INTERVAL:  15 MIN              NUMBER OF STEPS: 12
                                                                                       ACCUMULATED DISPLACEMENT
                                                                                                                  SPEED
                                              INCREMENTAL DISPLACEMENT              PATH       AZIMUTH       (ALONG PATH)
                                          RADIAL     AZIMUTH       SPEED           LENGTH   (FROM ORIGIN)
 STEP    TIME         LOCATION
   0    2000 CST   4274510N.  731225E.        0 M      0 DEG       0 M/SEC           0 M       0 DEG           0 M/SEC
   1    2015 CST   4279547N.  730624E.   4492.7 M  171.0 DEG    4.99 M/SEC      4492.7 M   171.0 DEG        4.99 M/SEC
   2    2030 CST   4283644N.  729845E.   4745.7 M  171.8 DEG    5.27 M/SEC      9238.3 M   171.4 DEG        5.13 M/SEC
   3    2045 CST   4288780N.  729547E.   5213.4 M  170.1 DEG    5.79 M/SEC     14451.8 M   170.9 DEG        5.35 M/SEC
   4    2100 CST   4294236N.  729221E.   5603.2 M  172.6 DEG    6.23 M/SEC     20055.0 M   171.4 DEG        5.57 M/SEC
   5    2115 CST   4299830N.  729121E.   5495.5 M  179.0 DEG    6.11 M/SEC     25550.5 M   173.0 DEG        5.68 M/SEC
   6    2130 CST   4305103N.  729661E.   5274.5 M  181.5 DEG    5.86 M/SEC     30825.0 M   174.5 DEG        5.71 M/SEC
   7    2145 CST   4310226N.  729403E.   5134.3 M  183.8 DEG    5.70 M/SEC     35959.3 M   175.8 DEG        5.71 M/SEC
   8    2200 CST   4315252N.  729352E.   5082.1 M  188.5 DEG    5.65 M/SEC     41041.4 M   177.4 DEG        5.70 M/SEC
   9    2215 CST   4320400N.  730398E.   5253.1 M  191.5 DEG    5.84 M/SEC     46294.4 M   179.0 DEG        5.72 M/SEC
  10    2230 CST   4325727N.  731847E.   5518.9 M  194.2 DEG    6.13 M/SEC     51813.4 M   180.7 DEG        5.76 M/SEC
  11    2245 CST   4331207N.  733437E.   5767.1 M  198.2 DEG    6.41 M/SEC     57580.5 M   182.4 DEG        5.82 M/SEC
  12    2300 CST   4336519N.  735365E.   5585.3 M  198.0 DEG    6.21 M/SEC     63165.9 M   183.8 DEG        5.85 M/SEC
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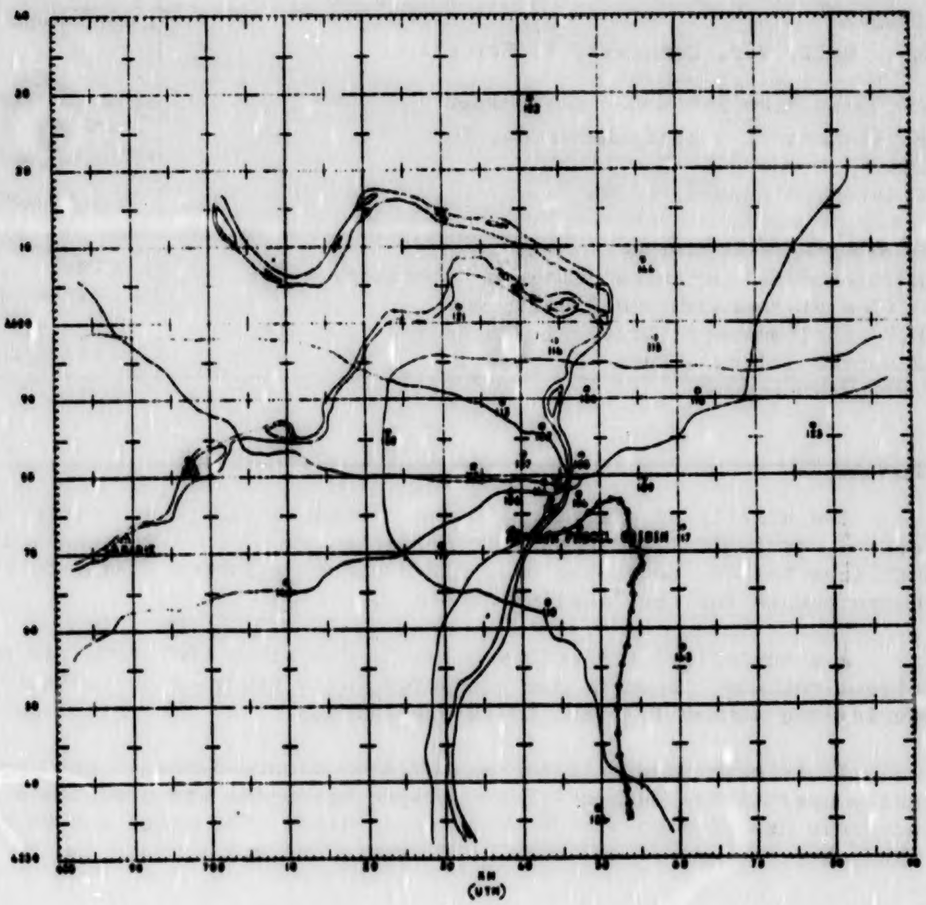
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4400
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4330
680
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700
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70
80
90
KM
(UTM)

RAMS NEAR-SFC
TRAJECTORY #50
ST. LOUIS, MO.
LOCATION DESCRIPTOR:
RAMS STATION NO. 111

STARTING 1000 CST 15 AUG 75
ARRIVING 1900 CST 15 AUG 75
TRAJECTORY START ★
DATA AVG INTERVAL- 900 SEC
INTEGRATION TIME STEP-900 SEC
SMOOTHING METHOD- INVERSE
FOREWARD TRAJECTORY